CANPOTEX POTASH EXPORT TERMINAL AND RIDLEY ISLAND ROAD, RAIL, AND UTILITY CORRIDOR

Aquatic Environment Technical Data Report

FINAL REPORT

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1 INTRODUCTION

1.1 Overview

Canpotex Terminals Ltd. (Canpotex) and the Prince Rupert Port Authority (PRPA) are jointly proposing the construction of a marine potash shiploading facility and road, rail and utility corridor on Ridley Island in Prince Rupert, BC (Figure 1-1). The Project will include the construction of a marine terminal, causeway, trestle and berth, a road and rail loop, and a 69kV powerline (Figure 1-2).

The objective of this technical data report is to document baseline conditions that are required to inform the environmental assessment of potential Project effects on the Aquatic Environment. Information on the marine component of the Aquatic Environment was obtained through site-specific field programs. The purpose of these field programs was to provide a species inventory and characterize baseline conditions at marine habitats that may be affected by the Project. The results of these marine field programs are presented in this report.

Information on the freshwater component of the Aquatic environment was obtained during past field programs on Ridley Island. The results of these studies are summarized in the following two reports: (Jacques Whitford AXYS 2007) and (Jacques Whitford AXYS 2008).

2 SURVEY METHODOLOGY

2.1 Marine Field Surveys

Marine habitats that may be affected by the Project were characterized through the completion of three survey types: intertidal, subtidal and tidal pond (see Table 2-1). A subtidal survey and two intertidal surveys (October 2008 and May 2009) were performed on the west coast of Ridley Island to characterize the areas that may be affected by construction of the marine terminal (causeway, trestle, and berth). A tidal pond survey and two intertidal surveys (August 2009 and June 2011) were performed on the northeast coast of Ridley Island (Porpoise Harbour) to characterize the areas that may be affected by infilling of the pond and nearby intertidal areas during construction of the road, rail and utility corridor.

Table 2-1: Marine Field Surveys, Dates and Personnel

Survey Type	Dates	Biologists
Intertidal Habitat Survey	October 13 – 15, 2008 May 23 – 27, 2009 August 5 – 6, 2009 June 14 – 17, 2011	Janine Beckett (Stantec) Tao Eastham (Stantec) Craig Losos (Stantec) Connor McCracken (Stantec) Brock Ramshaw (Stantec) Jason Thompson (Entech) Sandra Webster (Stantec)
Subtidal Video Survey	May 18 – 20, 2009	Barb Faggetter (Ocean Ecology)
Tidal Pond Survey	December 10 – 11, 2008	Craig Losos (Stantec)

2.1.1 Intertidal Habitat Characterization

Intertidal surveys were completed in October 2008, May 2009, August 2009 and June 2011. Surveys involved the use of systematic transects and quadrats designed to quantify habitat, species presence and identify any rare or common species or populations across the high, mid, and low intertidal zones. Surveys were completed during the best available low tide sequence to ensure adequate coverage of all intertidal zones.

Transects were placed along the Ridley Island shoreline in areas likely to be affected by Project construction activities. Transects were spaced to ensure that all habitat types were adequately surveyed. The top of each transect was located in the high intertidal zone which was defined as the highest point containing marine invertebrates and/or algae (i.e., top of the supralittoral zone). This point was photographed and recorded with a GPS and a tape measure was deployed directly seaward to the lowest point on the shoreline as permitted by the lowest tides. The width of the intertidal area was measured and general intertidal conditions noted and photographed to draft a cross-sectional shore profile showing substrate type, grade, and epibiota. The backshore zone was qualitatively documented and photographed.

Within each transect, low, mid and high intertidal zones were identified based on observations of notable differences in algae and invertebrate communities. The start and finish point of each zone was recorded from the transect tape and a clinometer was used to record the slope of each zone. Within each zone a species list was generated as was a biological description of the shoreline including a description of dominant macrophytes, invertebrate species, presence of rare or sensitive species, and general habitat characteristics. In addition, each zone was characterized based on general substrate classifications as described by Williams (1993):

- Boulder (>256 mm)
- Cobble (64 – 256 mm)
- Pebble (2 – 64 mm)
- Sand (0.0625 mm)
- Mud (mixed fine sand, silt, clay).

Along each transect, five 25 x 25 cm quadrats were laid randomly in each of the high, mid, and low intertidal zones within 3 m of the transect line. Within each quadrat all species were counted and identified. Algae and sessile invertebrate species were enumerated using percent coverage of the quadrat area. Large kelps were enumerated using percent coverage and number of individuals originating within the quadrat. Mobile invertebrates were enumerated by number of individuals, and highly mobile species were categorized as being incidental. Other important species not captured in the quadrats but identified in surrounding habitats were also noted as incidental. A list of all species identified during intertidal habitat surveys is presented in Appendix A.

2.1.1.1 Marine Terminal Area

Construction of the Project's marine terminal will interact with the marine environment along the west coast of Ridley Island, thus intertidal surveys were conducted along this shoreline in October 2008 and May 2009. Seven transects were surveyed along the west coast of Ridley Island as per the methodology discussed above (Section 2.1.1) to characterize the foreshore environment adjacent to the marine terminal (Figure 3-1).

2.1.1.2 Rail Loop Area

Construction of the Project's road and rail loop along the northeast side of Ridley will interact with the marine environment in Porpoise Harbour, thus intertidal surveys were conducted along this shoreline in August 2009 and June 2011. Ten transects were surveyed on the northeast side of Ridley Island as per the methodology discussed above (Section 2.1.1) to characterize the foreshore environment adjacent to the road and rail loop (Figure 3-2).

2.1.2 Tidal Pond Survey

A tidal pond on the northern end of Ridley Island will likely be affected by construction of the Project road and rail loop (Figure 3-2). A site reconnaissance of the pond was conducted in October 2008, which deemed the pond to be marine fish habitat. As a result, a subsequent sampling program occurred in December 2008 to assess the pond habitat.

The physical and biological characteristics of the pond were surveyed. Physical characteristics surveyed include bank slopes, water pH, substrate categorization, and general layout of the pond. The biological characteristics surveyed include riparian vegetation, invertebrates, fish species, and incidental sightings of waterfowl. To survey fish species, 12 minnow traps were deployed in the pond and left to soak for 24 hours. Fish captured in the traps were identified, measured for total length and photographed before being released.

2.1.3 Subtidal Video Survey

A detailed subtidal video survey was conducted by Ocean Ecology biologist Dr. Barb Faggetter in May 2009 in the area likely to be affected by the marine causeway, trestle, and berth (Figure 3-3). To characterize the subtidal zone, imagery of the seabed was collected using a DGPS-positioned, towed video camera. Tow speed was between 0.5 and 1 knot (0.8 knot average). The towed video system had two video cameras—one in a forward-looking orientation and one in a downward-looking orientation. These cameras provided composite video signals to an overlay unit that stamped the DGPS position data (latitude/longitude), together with date and time, on each video frame. The dual camera signals were then recorded using a digital video recorder. The video signal was also displayed in real-time on the vessel, where it was used to adapt the survey to particular features that were seen while underway. High intensity white LEDs were mounted on the camera to provide additional illumination when it was required. The camera was fitted with parallel scaling lasers mounted 3 cm apart to allow calculation of organism size. The altitude of the underwater camera was controlled using a hydraulic winch that was operated from the bridge while monitoring the real-time video feed. Typically, the camera was towed less than 1 m above the seabed.

The camera was towed along shore-normal and shore-parallel transect lines spaced 160 m apart. A total of 19 transects were recorded in a grid formation, as well as three transects following the contours of Coast Island, Ridley Island, and the rock reef immediately northeast of Coast Island. All survey track-lines were continued inshore to about 2 m water depth or to the limit of safe navigation. Surveys were carried out in waters up to 60 m depth.

Vegetation and fauna were identified from the video and mapped using GIS software. Due to the site's location in the plume of the Skeena River and the associated turbid water, the visibility at the time of the surveys was limited to a maximum of 1 m. As noted above high intensity LED lights were used to provide light, however back-scattering of light from suspended particles created additional visibility issues. In addition, strong currents occasionally made navigation of plotted transects difficult. Raw video of transects was reviewed and classified using a substrate and biotic classification similar to that used by the British Columbia Land Use Coordination Office (Howes 2001). A data record of substrate, plants, and organisms was produced for each second of video imagery.

Detailed methodology for the subtidal video surveys and species/substrate mapping is available in Appendix B.

2.1.4 Marine Mammal Observations

Marine mammal sightings were opportunistically collected during the Project-specific marine and wildlife field surveys and during the offshore sediment sampling program. When a marine mammal was observed, details were recorded on: species identity, number of individuals, date of observation, and location of observation.

3 SURVEY RESULTS

3.1 General Observations

3.1.1 Terminal Area

The western shoreline of Ridley Island is exposed to moderate wave action and has a relatively steep slope. Intertidal substrates are composed primarily of bedrock with scattered areas of boulder and cobble (Photo 1). A stretch of sandy beach is present to the east of Coast Island (Photo 2).

Photo 1: Typical bedrock substrate with a veneer of boulder and cobble near the proposed marine terminal on the west cost of Ridley Island

Photo 2: Sandy beach in the low intertidal zone to the east of Coast Island

The rocky intertidal habitat on the west coast of Ridley Island has a relatively high diversity and abundance of marine biota. This is likely due to the abundance of rock substrate and the moderate level of wave exposure. Rock substrate provides anchoring points for algae and sessile invertebrates, and increases structural complexity (e.g., interstitial spaces) for mobile epifauna. Wave action increases dissolved oxygen levels, which promotes algal growth, and helps to transport plankton and detrital matter, which are consumed by intertidal organisms.

Two important biogenic habitats were identified along the west coast of Ridley Island: kelp beds and eelgrass beds. The canopy-forming bull kelp (*Nereocystis luetkeana*) was observed in the shallow subtidal zone fringing the shoreline where rock substrate was present. Other large understory kelps including *Laminaria* spp., *Alaria* spp*., Costaria* spp*., Desmarestia* spp*.,* and *Cymathere* spp*.* were also identified in the low intertidal and shallow subtidal zones. These kelps are considered to provide important habitat for many invertebrate and fish species.

An eelgrass bed (*Zostera marina*) was identified along the stretch of sandy beach east of Coast Island. This bed fringes the shoreline in the lower intertidal and shallow subtidal zones, and is discontinuous over a distance of approximately 350 m. Eelgrass beds are considered important nursery habitat for juvenile fish and invertebrates.

Subtidal and sediment surveys indicated that seafloor substrates on the west coast of Ridley Island are comprised predominantly of silt and mud, with small patches of rock, cobble, and shell.

3.1.2 Rail Loop Area

The shoreline in Porpoise Harbour, adjacent to the proposed rail loop development area, is not exposed to wave action and has a gentle slope. The high and mid intertidal substrate is composed predominantly of rock, boulder and cobble, while the low intertidal and subtidal zones are predominantly mudflat (Photo 3). Shellfish ventilation holes are visible throughout these mudflat areas.

Algal and invertebrate diversity in Porpoise Harbour is low compared to the west coast of Ridley Island. This is likely due to the low wave exposure and limited water movement within Porpoise Harbour. No kelp or eelgrass beds were identified within the survey area.

Photo 3: Typical intertidal substrate near the proposed road and rail loop in Porpoise Harbour

3.2 Intertidal Habitat Characterization

A total of 17 intertidal transects were surveyed; seven along the west coast of Ridley Island near the proposed marine causeway and trestle and ten at the north end of Porpoise Harbour near the proposed road and rail loop. Transect locations are shown in Figures 3-1 and 3-2. General descriptions of the intertidal zones in each area are provided below.

A total of 49 species of algae, invertebrates, and fish were identified within survey quadrats. An additional 12 noteworthy species were observed outside of the transects in the immediate vicinity of the survey area. Detailed species lists can be found in Appendix A.

3.2.1 Terminal Area

High Intertidal Zone

The lower limit of this zone is approximately +2.5 m *chart datum* (CD) while the upper limit reaches into the spray zone.

The high intertidal zone macrophytes consist mostly of rockweed (*Fucus gardneri*). Red algae are mostly represented by Turkish washcloth (*Mastocarpus papillatus*) crust phase and sea sac (*Halosaccion glandiforme*). Various barnacles (*Balanus* spp.) are present in this zone, as well as hermit (*Pagarus* spp.) and shore (*Hemigrapsus* spp.) crabs. Plate (*Tectura* spp.) and ribbed (*Lottia* spp.) limpet species are also abundant. Almost all periwinkle species surveyed occur in the high zone, with checkered periwinkle (*Littorina scutulata*) being roughly twice as numerous as (*L. obtusata*).

Mid Intertidal Zone

The upper limit of this zone is approximately +2.2 to +2.5 m CD and the lower limit is approximately +1.2 m CD.

The macrophyte community in this zone is predominantly winged kelp (*Alaria* spp.) with some rockweed (*Fucus gardneri*) as well. Coralline crusts are abundant and the Turkish washcloth (*Mastocarpus papillatus*) crust is also well represented. Sea brush (*Odonthalia flocossa*), black pine (*Neorhodomela larix*), and sea sac (*Halosaccion glandiforme*) represent other prominent red algae in this zone. The thatched acorn barnacle (*Semibalanus cariosus*) is the most abundant invertebrate in the mid intertidal zone. The dire whelk (*Lirabuccinum dirum*) and the plate limpet (*Tectura* spp.) are also common. The mid intertidal zone is also host to the only breadcrumb sponge (*Halichondra* spp.) observed during the survey.

Low Intertidal Zone

The upper limit of this zone is approximately +1.2 m CD and the lower limit is 0 m CD.

The low intertidal zone is dominated by tangle kelp (*Laminaria* spp.), sea brush (*Odonthalia flocossa*), and black pine (*Neorhodomela larix*). Bull kelp (*Nereocystis luetkeana*) fringes this zone in the shallow subtidal. Other red algae found in the diverse low intertidal zone include the iridescent seaweed (*Mazaella splendens*) and the crimson veined seaweed (*Polyneura* spp.). Flattened acid leaf kelp (*Desmarestia* spp.) was also observed in this zone, but did not fall within any of the transects. The invertebrate community surveyed in the low intertidal zone contained some species not seen in the two higher zones. The topsnail (*Calliostoma* spp.) and the lined chiton (*Tonicella lineata*) are noteworthy species of molluscs identified in this zone. The low intertidal zone was also the only place decorator crab (*Oregonia gracilis*), humpback shrimp (*Pandalus hypsinotus*), and other shrimp (*Pandalus* spp.) were observed.

3.2.2 Rail Loop Area

High Intertidal Zone

The high intertidal zone in is dominated by rockweed (*Fucus gardneri*). Other algae in this zone include Turkish washcloth (*Mastocarpus papillatus*), nail brush seaweed (*Endocladia muricata),* and yellow seaweed (*Mastocarpus jardinii).* High densities of the acorn barnacle (*Balanus glandula)* and to a lesser extent little acorn barnacle (*Chthamalus dalli*) are attached to rock substrate underneath macrophyte cover. Shore crabs (*Hemigrapsus nudus*), periwinkles (*Littorina scutulata and L. sitkana*) and various species of limpets (*Lottia* spp.) are also abundant. Other invertebrates identified in this zone include amphipods (*Traskorchestia* sp*.),* hermit crabs (*Pagurus* spp*.),* mites *(Neomolgus littoralis),* mussels (*Mytilus* spp*.)*, an unknown species of nemertean and one tube worm from the family Sabellidae.

Mid Intertidal Zone

Rockweed (*Fucus gardneri*), Turkish washcloth (*Mastocarpus papillatus*), nail brush seaweed (*Endocladia muricata*), and yellow seaweed (*Mastocarpus jardinii*) are the dominant macrophytes in the mid intertidal zone. Patches of sea lettuce (*Ulva lactuca*), green string lettuce (*Ulva intestinalis*), sea moss (*Cladophora* spp.), and sugar wrack kelp (*Laminaria saccharina*) are also present. Barnacles (Balanus glandula), periwinkles (*Littorina scutulata*), and limpets from the genus *Lottia* were recorded on all transects, while other, less abundant invertebrates include *Littorina sitkana*, mites (*Neomolgus littoralis*), mussels (*Mytilus* spp.), shore crabs (*Hemigrapsus nudus*) and hermit crabs (*Pagurus* spp.).

Low Intertidal Zone

The low intertidal zone in Porpoise Harbour is primarily mudflat, with occasional patches of cobble. This zone had the lowest diversity of surface organisms of all intertidal areas surveyed.

Sea lettuce (Ulva lactuca) and sugar wrack kelp (Laminaria saccharina) were the most abundant algae and were recorded on approximately half of all transects. Moss ball seaweed (*Cladophora* sp*.*) and two unknown species of red algae were the only other macrophytes present in this zone. Surface invertebrates in this zone included various limpet species (*Lottia* spp.), tube worms (Sabellidae), sea squirts (*Cnemidocarpa finmarkiensis*) and a single snail (*Calliostoma* sp*.*). Siphon holes were present in approximately half of all quadrats showed evidence of infaunal invertebrates living below the surface. While most of these siphon holes probably belonged to bivalves, some of the holes may have marked burrows of Polychaetes and Crustaceans. Both clams (*Clinocardium* sp.) and ghost shrimp (*Neotrypaea californiensis*) were observed in the low intertidal zone but did not fall within any of the quadrats.

3.3 Subtidal Video Survey

The subtidal video survey revealed a relatively high diversity of vegetation and fauna within the survey area. Summaries of substrate, vegetation, fish, and invertebrates are provided below. For details of the subtidal video and figures of biophysical survey results, see Appendix B. The subtidal survey transect layout is presented in Figure 3-3.

3.3.1 Subtidal Substrate

Video of the subtidal transects revealed relatively uniform substrate across the survey area. The substrate observed consisted almost entirely of silt-mud, with traces of shell and wood debris. Bedrock is present around Coast Island, the reef to the northeast of Coast Island, and around Bacon Rock. The shorelines of Ridley Island and Coast Island contained some sand substrate. The sheltered wave effect between Coast Island and Ridley Island resulted in the deposition of large amounts of organic debris in that area.

3.3.2 Subtidal Vegetation

Shallow subtidal areas in the vicinity of Coast Island and the reef northeast of Coast Island exhibited a diverse community of subtidal algae. The Ridley Island shoreline was less diverse; however, a fringing eelgrass bed was associated with the sandy substrate.

Algal abundance declined moving away from shore due to the rapid decrease in light in the offshore environment. Heavy siltation and high turbidity act to reduce algal abundance. It is important to note that the video survey was performed during early spring due to Project time constraints. Macrophyte cover is typically lower during winter; thus, current abundance measures likely underestimate the full growth of marine vegetation.

Foliose red algae were the dominant algal species in the survey area, while sugar wrack kelp (*Laminaria* spp.) was the most abundant brown algae. Habitat-forming canopy kelp beds of bull kelp (*Nereocystis luetkeana*) were observed on the west and north sides of Coast Island and around the reef northeast of Coast Island (Figure 3-6). Subsurface bull kelp was observed on the east side of Coast Island and along Ridley Island shoreline, and can be expected to form a kelp canopy during summer months.

Eelgrass was found along the southeast shore of Coast Island and in a band along the shoreline of Ridley Island (Figure 3-6). The observed coverage of these eelgrass beds was generally below 75% but can be expected to increase throughout the summer growing season.

3.3.3 Marine Fish

Fish were found in moderate abundance throughout the survey site. The most common fish were Northern ronquils (*Ronquilus jordani*), eelpouts, and unidentified flatfish. Based on the known distributions and habitat requirements of flatfish in British Columbia, it is likely that the observed flatfish included English sole (*Parophrys vetulus*). Longnose skate (*Raja rhina*) and black-eyed goby (*Lepidogobius lepidus*) were also observed at low abundance The majority of fish were found in water depths greater than 10 m.

3.3.4 Subtidal Invertebrates

There were a number of commercially important invertebrate species observed in the survey area. Spiny pink shrimp (*Pandalus borealis eous*) were considered to be very abundant. Spot prawns (*Pandalus platyceros*) were present in low abundance. Both of these *Pandalus* species shared similar distribution along the deeper, western portion of the survey area. Commercial crab harvesting operations took place at the site throughout the May survey, indicating a relatively productive area for Dungeness crab. Geoduck clams (*Panopea abrupta*) were present in moderate abundance throughout the survey area and were associated with unmounded holes. California sea cucumbers (*Parastichopus californicus*), and scallops (*Chlamys* spp.) were present at low to very low abundance in the survey area.

There was a high occurrence of unmounded holes observed throughout the survey area. These holes are surface disturbances and are indicative of a number of invertebrate species: burrowing polychaete worms, certain bivalve species, and mud shrimp. Accurate identification of these species was generally not possible.

Echinoderms formed the most diverse species group within the survey area. Invertebrate species richness was highest around Coast Island and the rock reef northeast of Coast Island. This higher species diversity is correlated with shallow, well-lit regions that support good algal growth and rocky, rugged terrain that provides adequate attachment opportunity for organisms.

3.4 Tidal Pond Survey

The pond on the northeast corner of Ridley Island is approximately 155 m long and 30 m across at its widest point. It is formed by anthropogenic structures and landscapes. A gravel road runs along its northeast and southern edges, and the pond is located between railway lines to the northwest and the Ridley Island Log Sort to the southeast. A map showing the pond location and habitat layout is presented as Figure 3-7.

The pond is fed on its south end by a small stream (average stream wetted width: 0.63 m; average depth: 0.14 m). This stream is separated from the pond by a berm and road, through which there is no culvert. The creek has a recorded pH of 4 – 5, indicating acidic water that is inhospitable to most fish and their eggs (Alabaster and Lloyd 1982; Freda and McDonald 1988). The inflow from this creek comes through the berm, thus there is no connectivity between the stream and the pond. Adjacent to this stream, water from the Ridley Island log sort drains over the road and into the pond (Photo 4). This water may contain contaminants originating from the log-sort and is more acidic than the stream (pH =3.0).

Photo 4: Berm on south end of tidal pond that lacks culvert to stream. Runoff from Ridley Island Log Sort can be seen flowing across the road from left to right in foreground.

In addition to the freshwater flowing through the berm, the pond is tidal and is connected to the marine environment at the southeast via two corrugated culverts measuring approximately 35 m in length and 0.91 m diameter that run under the road. These culverts are placed roughly at the high water mark, connecting the pond to the ocean only when tides are high (Photo 5). The culverts run nearly parallel to one another, being slightly closer together in the pond (1.3 m center to center) than at the ocean (1.9 m). When the water levels are below the culverts, water filters through the berm on which the road is placed–there is no connectivity for fish at these times despite flow of water between the pond and Porpoise Harbour.

Photo 5: Two corrugated culverts on the pond side of the road. No connectivity occurs when tide levels are below the culverts.

The banks of the pond are predominantly steep (47° incline), rip rap and cobble slopes. The banks are lined with trees and bushes along the east, north, and western edges. The south edge is devoid of any vegetation. The trees surrounding the pond are dominated by red alder (*Alnus rubra*) while other common species include yellow cedar (*Chamaecyparis nootkatensis*), western hemlock (*Tsuga heterophylla*), and coastal Douglas fir (*Pseudotsuga menziesii*).

There is a small, grassy area of flat ground in the north-eastern corner of the pond. In this area, the bank slope is much more gradual (17° incline) and the substrate is mostly mud (Photo 6). The flat area is dominated by red fescue grass (*Festuca rubra*) as well as salal (*Gaultheria shallon*) and Douglas' water hemlock (*Cicuta douglasii*).

Photo 6: North-oriented photograph of pond with flat, grassy area on the right, steep rip rap banks lined with trees, and the CN rail line visible in the background.

General observations of organisms in the pond include barnacles (*Balanus* spp.) and mussels (*Mytilus* spp.) as well as use by mallard ducks (*Anas platyrhynchos*) during site visits. Fish traps yielded sculpins (*Artedius* spp.) and purple shore crabs (*Hemigrapsus nudus*). Seven sculpins ranging in length from 104-124 mm were caught in 5 of the 12 traps. Two purple shore crabs were caught in separate traps.

3.5 Marine Mammal Observations

Opportunistic sightings of marine mammals were recorded during the marine and wildlife field surveys, and during the offshore sediment sampling program. All incidental species sightings are summarized in Table 3-1.

Table 3-1: Incidental Marine Mammal Observations

Species	Number	Date	Location	Observer*
Harbour Seal	9	June 2010	West coast Ridley Island (1); Porpoise Harbour (8)	M. D'Entremont T. Anderson M. Willie
	5	July 2011	West coast Ridley Island (2); Porpoise Harbour (3)	M. Willie D. Brown

Species	Number	Date	Location	Observer*
Steller Sea Lion	1	June 2010	West coast Ridley Island	T. Anderson M. Willie
Harbour Porpoise	1	July 2011	West coast Ridley Island	M. Willie D. Brown
Dall's Porpoise	4	June 2010	West coast Ridley Island	T. Anderson M. Willie
Humpback Whale	~12-16	November 2010	West coast Ridley Island – offshore of coal and grain terminals	J. Beckett

NOTES:
* All observers are Stantec environmental scientists

Three of the marine mammal species observed are federally protected by the *Species at Risk Act* (SARA): the Steller sea lion is listed under Schedule 1 as a species of *Special Concern*; the harbour porpoise is listed under Schedule 1 as a species of *Special Concern*, and the humpback whale is listed under Schedule 1 as *Threatened*.

4 SUMMARY

The objective of the marine field program was to provide a species inventory and characterize baseline conditions at marine habitats that may be affected by the Project. Field surveys focused on areas that are likely to be directly affected during construction of in-water infrastructure, including the marine causeway, trestle and berth, and the road, rail and utility corridor. The data presented in this report will be used to support the regulatory decision-making process as well as the assessment of potential Project effects on the Aquatic Environment.

Marine habitats surveyed around Ridley Island are typical of the North Coast of British Columbia. Intertidal surveys conducted along the west coast of Ridley Island, in the area likely to be affected by construction of the marine terminal, found a relatively high diversity and abundance of algae and invertebrates. Two important biogenic habitats—kelp beds and eelgrass beds—were also identified in this area. Intertidal surveys conducted in Porpoise Harbour, in the area likely to be affected by construction of road and rail loop, found a lower diversity of marine biota in this protected habitat when compared with the western shoreline of Ridley Island. This result likely reflects the low wave exposure and limited water movement in Porpoise Harbour.

The subtidal video survey revealed that the seafloor on the west coast of Ridley Island is dominated by mud and silt. Invertebrate and fish species identified in this survey reflect the soft sediment benthic habitat. Areas of high species richness were confined to shallow rocky habitats around Coast Island and in the vicinity of the rock reef northeast of Coast Island.

The tidal pond survey characterized the pond as low quality marine fish habitat. The pond is anthropogenic in origin, has very low pH, and exhibits limited connectivity to the marine environment. Few organisms were observed living within the pond.

Marine mammals observed opportunistically during field surveys included harbour seals, Steller sea lions, harbour porpoises, Dall's porpoises and humpback whales. Harbour seals and harbour porpoises are expected to be common year-round in the waters surrounding Ridley Island. Steller sea lions and humpback whales are expected to be more abundant during the summer months.

Overall, the field surveys described in this report provided good coverage of the marine habitats likely to be affected by the Project. The species inventory obtained through these surveys represents the suite of marine organisms that have the potential to be affected by Project construction and operation. However, it should be noted that this list is not exhaustive. Additional species not identified during field surveys may occur in the waters around Ridley Island. These include seasonally abundant fish (e.g., Pacific salmon (*Oncorhynchus* spp.), Pacific herring (*Clupea pallasi*), eulachon (*Thaleichthys pacificus*), rare and/or cryptic invertebrates, and some marine mammals. Thus, the fact that a species was not identified during the marine field program does not preclude its presence in marine habitats around Ridley Island.

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6 FIGURES

Please see the following pages.

REF: Department of Energy, Mines and Resources - Map 103 J

Scale 1:200,000

Client: Canpotex / PRINCE RUPERT PORT AUTHORITY	Job No.: 123110264	Fig. No.:	Stantec
	Scale: 1:200,000	1.1	
	Date: 24-Oct-11		
PROJECT LOCATION AQUATIC ENVIRONMENT TECHNICAL DATA REPORT RIDLEY ISLAND, BRITISH COLUMBIA	Dwn. By: NP		
	App'd By: SW		

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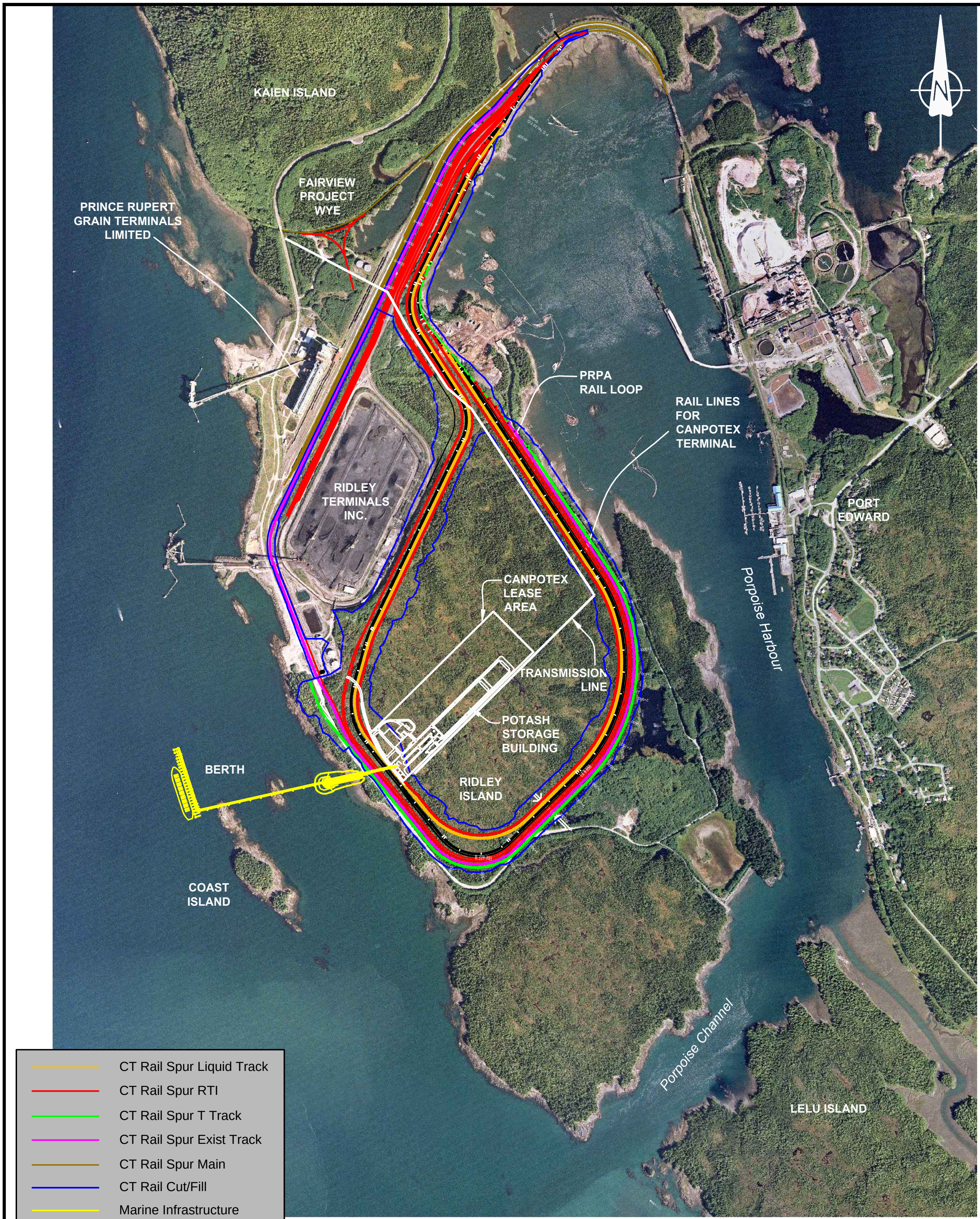

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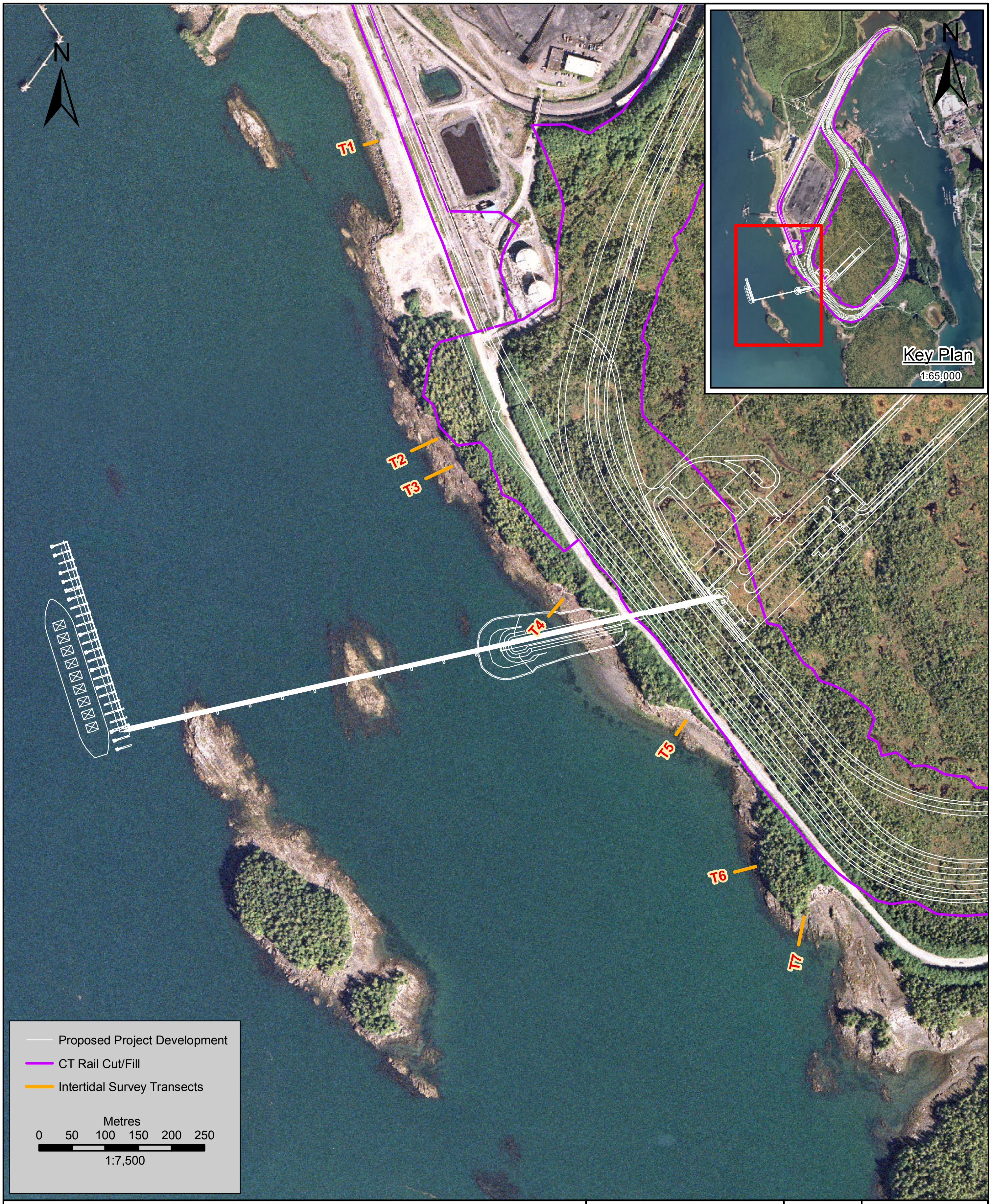

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	App'd By: SW	

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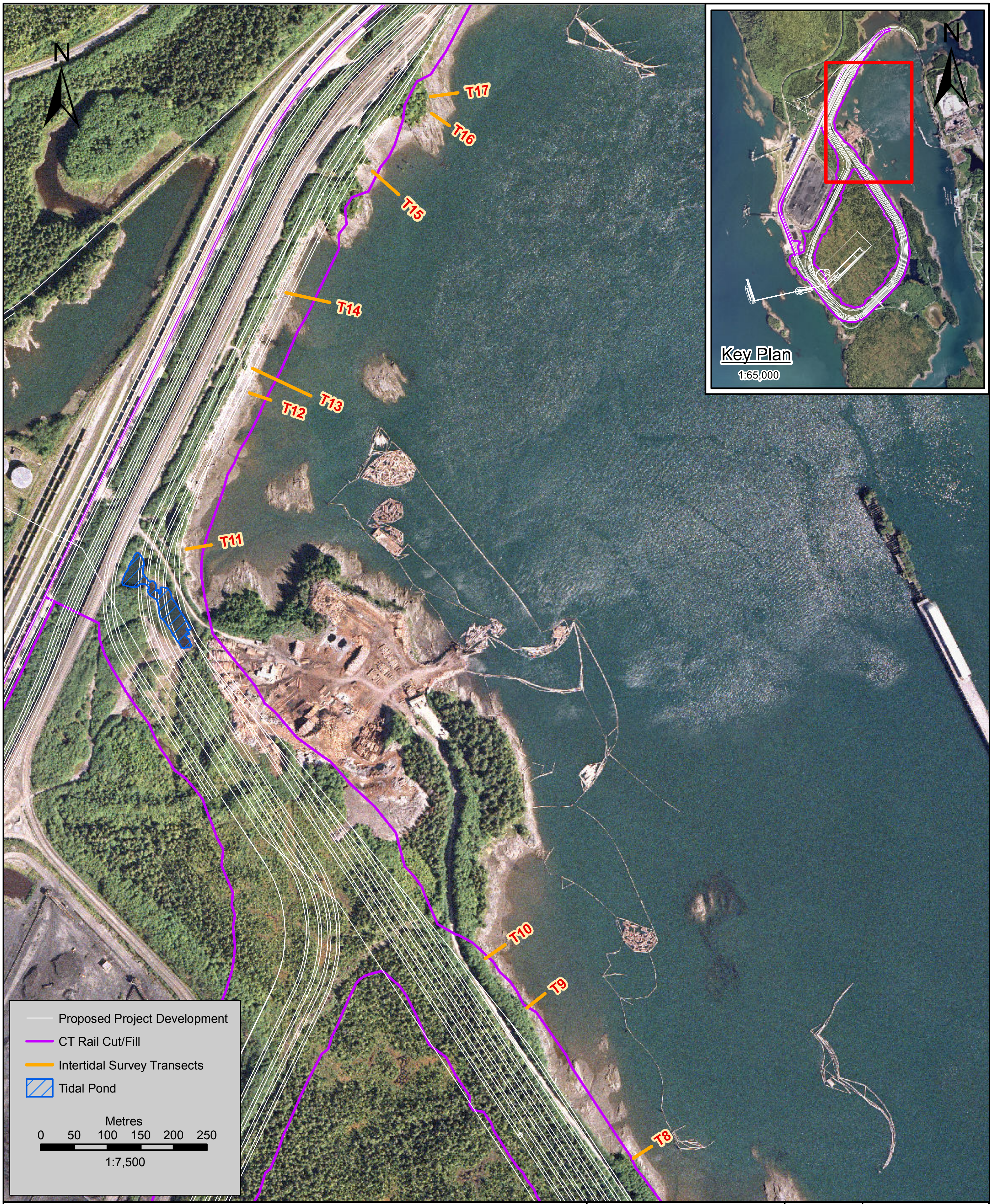

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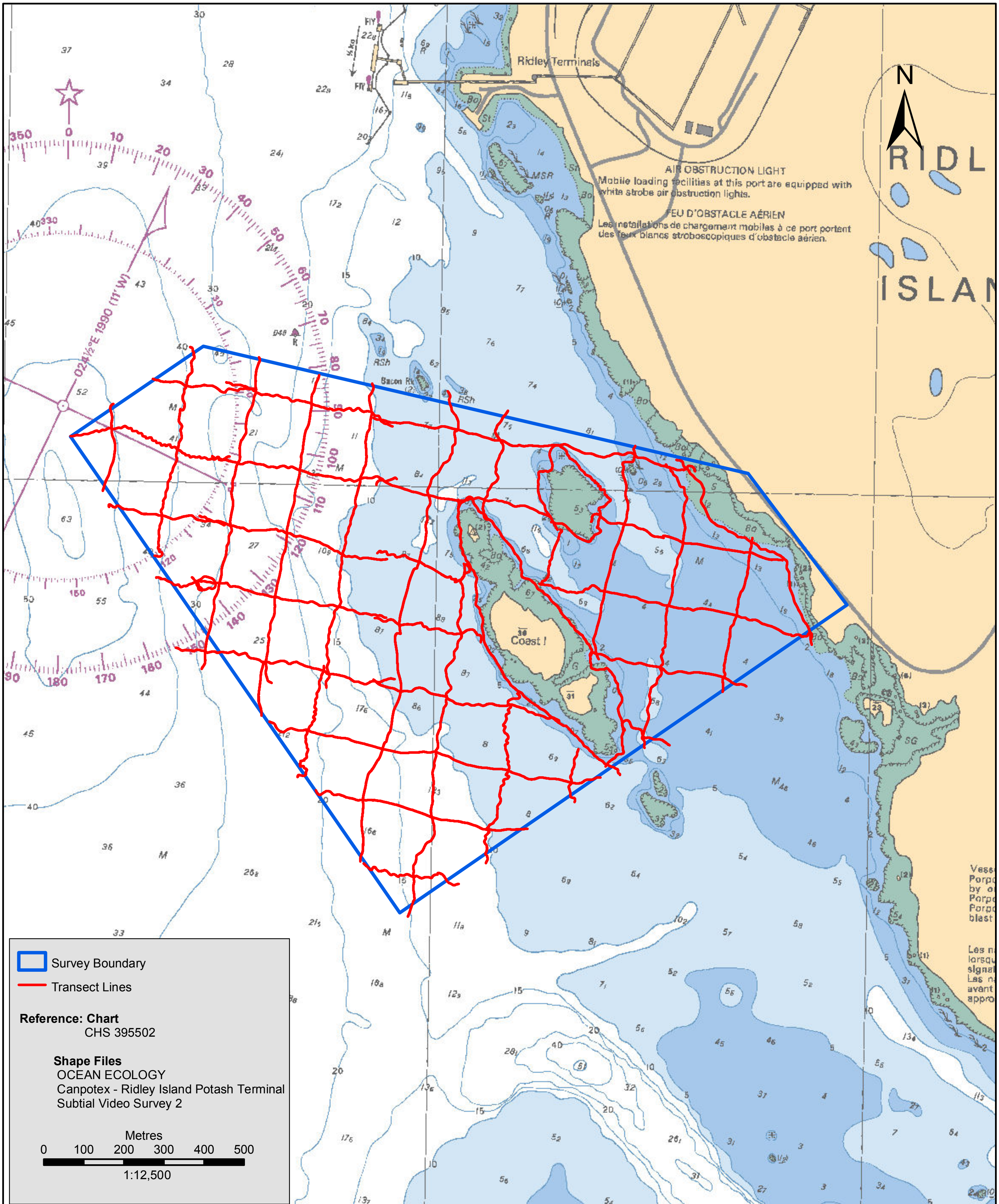

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	App'd By: SW	

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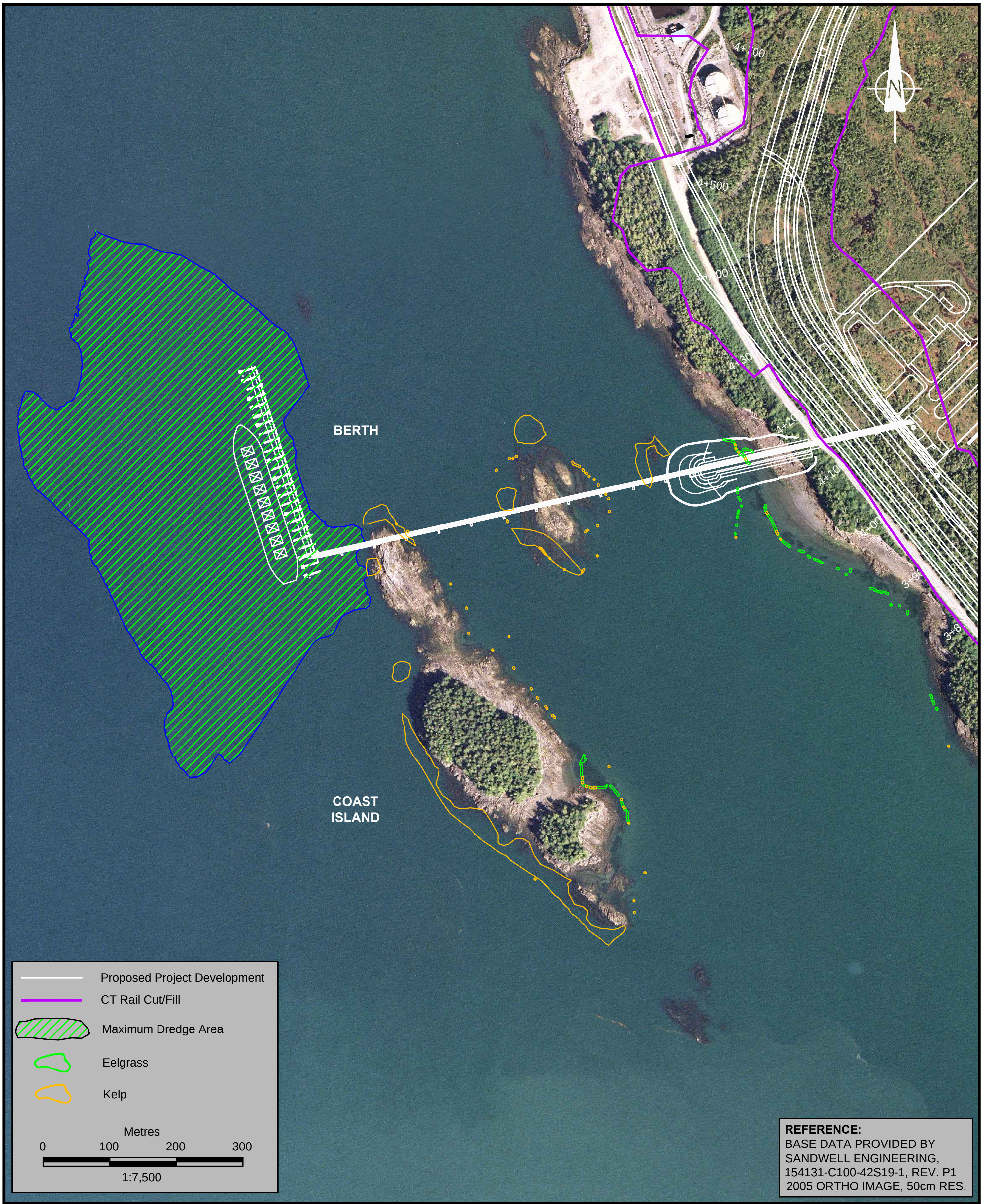

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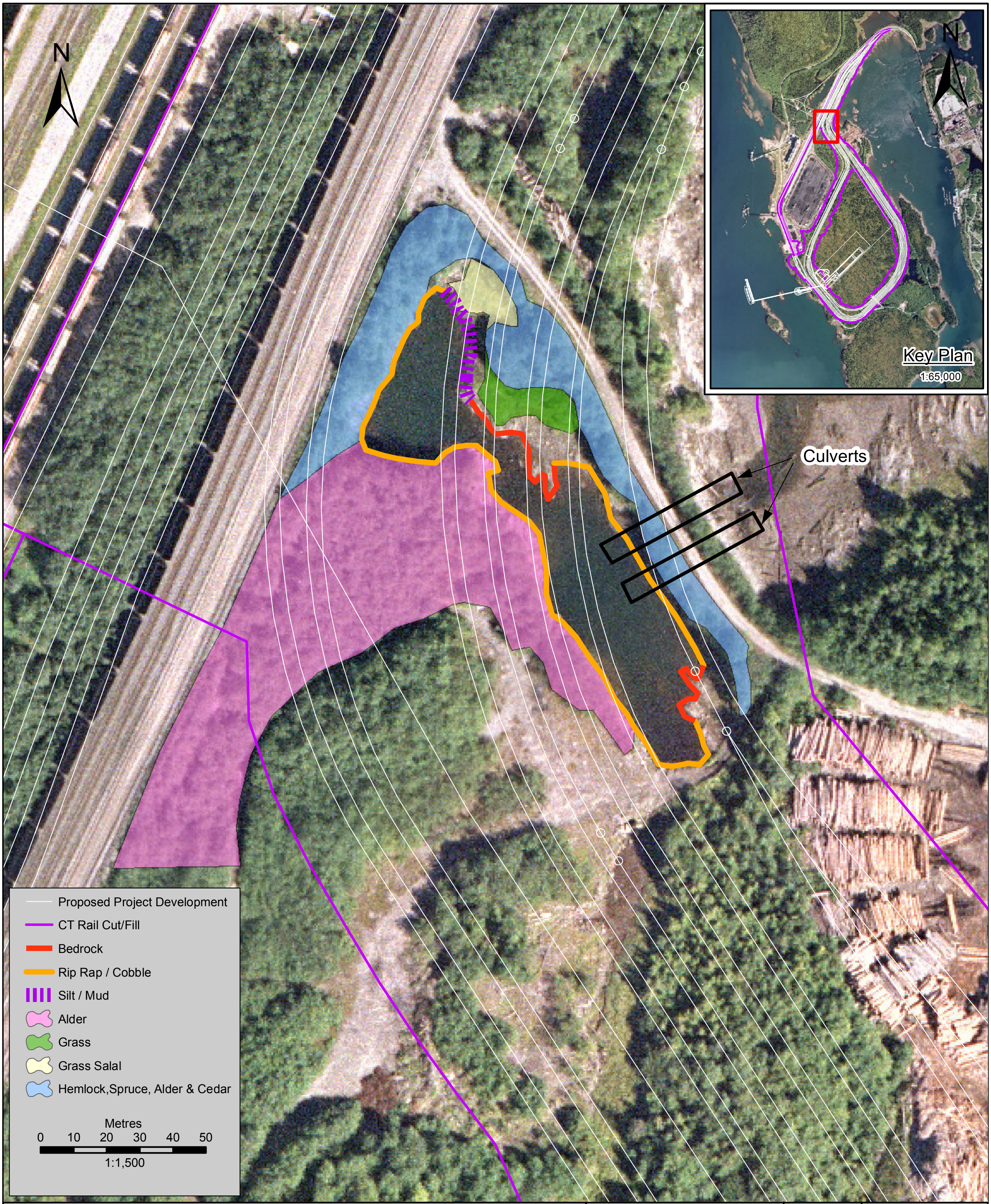
Client: Canpotex PRINCE RUPERT PORT AUTHORITY

Job No.:	123110264
Scale:	1:7,500
Date:	24-Oct-11
Dwn. By:	NP
App'd By:	SW

Fig. No.: 3-6

KELP AND EELGRASS HABITATS
AQUATIC ENVIRONMENT TECHNICAL DATA REPORT
RIDLEY ISLAND, BRITISH COLUMBIA

Stantec



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	App'd By:	SW		

APPENDIX A

Intertidal Species List

Table A-1: Mean Abundance (number of individuals or % cover) of Intertidal Species Identified in the Terminal Area Foreshore Survey and the Proportion of Transects in which each was Observed

Group	Species	High Intertidal Zone			Mid Intertidal Zone			Low Intertidal Zone		
		Average per Quadrat		Proportion of Transects	Average per Quadrat		Proportion of Transects	Average per Quadrat		Proportion of Transects
		Number of Individuals	% Cover		Number of Individuals	% Cover		Number of Individuals	% Cover	
Limpet	*Tectura* spp	0.57		0.75	0.4		0.5	0.3		0.25
Limpet	*Lottia* spp	0.43		0.75	0.5		0.5	0		0
Mussels	*Mytilus* spp complex		1.7	0.5		0	0		0	0
Snail	*Tegula*	1.94		0.875	0		0	0		0
Snail	*Lirabuccinum dirum*	0.45		0.25	0.9		0.5	0.2		0.25
Snail	*Nucella lamellosa*	0.6		0.13	0.2		0.375	0.4		0.125
Snail	*Littorina scutulata*	0.87		0.375	0		0	0		0
Snails	*Calliostoma*	0		0	0		0	0.2		0.25
Snail	Unknown Snail	2		0.125	0		0	0		0
Chitons	Katharina	0.2		0.125	1.27		0.375	0.2		0.125
Chitons	*Cryptochiton stellari*	0		0	0		0	0.6		0.125
Chitons	*Mopalia*	0		0	0.2		0.125	0.2		0.125
Chitons	unknown juv. Chiton	0.6		0.125	0.4		0.125	0		0
Chitons	*Tonicella Lineata*	0		0	0.2		0.125	0.53		0.375
Crabs	*Pagarus*	0.2		0.625	0.3		0.5	0.2		0.5
Crabs	*Hemigrapsus*	0.27		0.375	0		0	0		0
Crab	*Pugettia*	0		0	0		0	0.2		0.25
Barnacles	*Balanus* spp.		15.87	0.75		0.9	0.25		13.5	0.25
Barnacles	*Semiballanus Cariosus*		13.28	0.75		42.35	0.5		11.5	0.25

Group	Species	High Intertidal Zone			Mid Intertidal Zone			Low Intertidal Zone		
		Average per Quadrat		Proportion of Transects	Average per Quadrat		Proportion of Transects	Average per Quadrat		Proportion of Transects
		Number of Individuals	% Cover		Number of Individuals	% Cover		Number of Individuals	% Cover	
Shrimp	Unknown shrimp spp.	0		0	0		0	0.2		0.125
Echinoderms	*Leptasterias hexactis*	0		0	0.2		0.375	0		0
Worms	*Serpula* spp	0		0	0		0	2.4		0.125
Worms	*Eudistylia vancouveri*	0		0	3		0.125	2		0.125
Worms	Unknown worm	0		0	0.2		0.125	0.4		0.125
Isopod	*Idotea resecata*	0.2		0.25	0.2		0.125	0.2		0.375
Bryozoans	*Bryozoan* spp.		0	0		0	0		0.2	0.125
Sponge	*Halichondria* spp.		0	0		1.7	0.25		0	0
Fish	Clingfish	0		0	0		0	0.2		0.125
Fish	Prickleback	0		0	0		0	0.2		0.125
Red Algae	Coralline Crust		10.87	0.375		8.04	0.625		14.17	0.75
Red Algae	Cryptopleura		0	0		0	0		4.27	0.375
Red Algae	Halosaccion		11.8	0.625		8.83	0.75		13.4	0.25
Red Algae	Mastocarpus blade		8.37	0.875		6.8	1		3.96	0.625
Red Algae	Mastocarpus crust		43.91	0.875		10.43	0.875		5.5	0.75
Red Algae	Mazzaella		2.6	0.125		9	0.5		8	0.875
Red Algae	Odonthalia		16	0.125		4.2	0.625		12.33	0.375
Red Algae	Porphyra		4.5	0.5		4.52	0.625		10	0.125
Red Algae	Neorhodomella		4.33	0.375		20.87	0.75		20.2	0.625
Red Algae	Microcladia		0	0		10.25	0.5		37.2	0.25
Red Algae	Chondracanthus		0.5	0.25		0	0		0	0
Red Algae	Unknown Red #1		38	0.125		1	0.125		5	0.125

Group	Species	High Intertidal Zone			Mid Intertidal Zone			Low Intertidal Zone		
		Average per Quadrat		Proportion of Transects	Average per Quadrat		Proportion of Transects	Average per Quadrat		Proportion of Transects
		Number of Individuals	% Cover		Number of Individuals	% Cover		Number of Individuals	% Cover	
Red Algae	Unknown Red #2		2	0.25		1	0.125		0	0
Red Algae	Unknown Red #3		0.4	0.125		3	0.25		10	0.375
Red Algae	Unknown Red #4		2	0.125		49	0.125		1	0.125
Red Algae	Unknown Red #5		0	0		0	0		12	0.125
Red Algae	Unknown Red #6		0	0		3	0.125		33	0.125
Red Algae	Turkish Towel		0	0		0	0		1	0.125
Red Algae	Palmaria		0.6	0.125		13.87	0.375		15	0.875
Red Algae	Ceramium		2.4	0.125		0	0		2	0.25
Red Algae	Endocladia		5.5	0.25		4.2	0.125		0	0
Green Algae	Acrosiphonia		2.5	0.25		4.24	0.625		5.7	0.5
Green Algae	Ulva		13.33	0.375		19.46	0.875		9.85	0.5
Brown Algae	Fucus		74	1		18.5	0.75		0	0
Brown Algae	Laminaria	0	0	0	0	3	0.125	1.4	30.717	0.875
Brown Algae	Alaria	1.3	1.3	0.25	3.6	6.8	0.875	4.88	24.08	0.625
Brown Algae	Desmarestia		0	0		0	0		13.8	0.25
Brown Algae	Unidentified Brown #2		0	0		0	0		0.4	0.125
Brown Algae	Nereocystis	0	0	0	0	0	0	0	5	0.125
Brown Algae	Ralfsia		0.6	0.125		0	0		0	0

Table A2: Mean Abundance (number of individuals or % cover) of Intertidal Species Identified in the Rail Loop Foreshore Survey and the Proportion of Transects

Group	Species	High Intertidal Zone			Mid Intertidal Zone			Low Intertidal Zone		
		Average per Quadrat		Proportion of Transects	Average per Quadrat		Proportion of Transects	Average per Quadrat		Proportion of Transects
		Number of Individuals	% Cover		Number of Individuals	% Cover		Number of Individuals	% Cover	
Limpet	*Tectura* spp.	9.07		1	11.17		1	1.6	-	0.33
Mussels	*Mytilus* spp. complex		0.52	0.83		0.4	0.67		0	0
Snail	Unknown snail	3.4		1	1.9		0.67	0		0
Snail	*Littorina* spp.	9.07		1	1.67		1	0.2		0.17
Crabs	*Pagarus*	0.2		0.33	0.3		0.33	0.2		0.17
Crabs	*Hemigrapsus nudus*	0.4		0.33	0		0	0		0
Barnacles	*Balanus* spp.		8.03	1		6.93	1		0.45	0.67
Barnacles	Unknown barnacle	-	0	0		0.2	0.17		0	0
Amphipod	Unknown amphipod spp.	0.2		0.33	0		0	0		0.125
Worms	*Serpula* spp.	0		0	0		0	1.2		0.17
Worms	Unknown worm	0.2		0.17	0.2		0.17	0		0
Isopod	*Idotea wosnesenski*	0.2		0.17	0		0	0		0
Red Algae	*Mastocarpus blade*		0.6	0.17		0	0		0	0
Red Algae	*Mastocarpus crust*		2	0.17		0	0		0	0
Red Algae	*Mazzaella* spp.		0	0		0	0		0.4	0.17
Red Algae	*Mazzaella oregona*	-	0	0	-	0.2	0.17	-	0.4	0.17
Red Algae	*Neorhodomella*		0.2	0.17		1	0.17		0	0
Red Algae	*Endocladia*		4.2	0.33		2	0.17		0	0

Group	Species	High Intertidal Zone			Mid Intertidal Zone			Low Intertidal Zone		
		Average per Quadrat		Proportion of Transects	Average per Quadrat		Proportion of Transects	Average per Quadrat		Proportion of Transects
		Number of Individuals	% Cover		Number of Individuals	% Cover		Number of Individuals	% Cover	
Green Algae	*Acrosiphonia*		10	0.17		1	0.17		0.9	0.33
Green Algae	*Leathesia difformis*		0.2	0.17		1	0.17		0	0
Green Algae	Ulva intestinalis		0	0		0.4	0.17		6.48	0.17
Green Algae	Ulva spp.		0	0		0.2	0.33		3.8	0.5
Brown Algae	Fucus		39.2	1		5.67	1		1	0.17
Seaweed	Unknown 3		0	0		0	0		0.2	0.17

APPENDIX B

Subtidal Video Survey Report

Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

May 2009

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Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Prepared for: Craig Losos, M.Sc., Marine Biologist
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Prepared by: Ocean Ecology

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Executive Summary

A DGPS-positioned, towed video camera system was used to collect imagery of the seabed. Nominal shore-normal and shore-parallel transect line spacing was 160 m. Cross-over points between the shore-normal and shore-parallel transect lines were used to determine the confidence levels in the interpretation of the image data. Surveys were carried out in waters up to 60 m depth.

A data record of substrate and biota classes was produced for each second of video imagery using a substrate and biotic classification similar to that used by the British Columbia Land Use Coordination Office (LUCO).

All classification data was entered into a relational database. Maps of observed species distribution and estimated species ranges were produced using ArcGIS. A library of linked and searchable video annotations was produced.

The overall confidence level of the survey was 92%. Poor visibility was the main reason for decreased confidence levels.

The following substrate and biota features were observed:

1. The site is located directly in the plume of the Skeena River, resulting in normally high turbidity. As a result, the visibility at the site seldom exceeded 1 m.
2. Based on video observations, the site substrate consisted largely of silt-mud, with some shell, wood, and organic debris. Bedrock occurred around Coast Island, the reef to the NE of Coast Island, and Bacon Rock. Sand was present along the shore or Ridley Island, and to a lesser extent, around Coast Island and the reef to the NE of Coast Island.
3. Commercial crab harvesting operations took place at the site throughout the duration of the survey. The presence of crab gear on the seafloor was observed frequently in the video footage.
4. In many of the shallow areas around Coast Island and the reef to the NE of Coast Island, vegetation dominated the benthic environment. Vegetation was less dominant along the Ridley Island shoreline; however, significant amounts of eelgrass were present.
5. The most dominant alga in terms of both number of observations and area was sugar wrack kelp.
6. Based on a statistical analysis of the data, the highest concentrations of bull kelp (*Nereocystis*) were found around the rocky reef to the NE of Coast Island, at the northern tip of Coast Island, and along the SW shore of Coast Island.
7. Six other species of kelp were observed at the site: *Laminaria setchellii* (split kelp), *Laminaria saccharina* (sugar wrack kelp), *Laminaria yezoensis* (suction-cup kelp), *Costaria costata* (seersucker kelp), *Agarum fimbriatum* (fringed sea colander kelp), and *Alaria* sp.
8. Eelgrass was found along the SE shore of Coast Island, and in a strip along the section of Ridley Island shore that was surveyed. While present, the eelgrass beds were relatively sparse in nature, seldom exceeding 75% cover. Based on a statistical analysis of the data, the highest concentrations of eelgrass were found in a small area along the SE shore of Coast Island and in a patch along the northern section of the Ridley Island shoreline.
9. The most dominant fauna in terms of both number of observations and area were unmounded holes. Unmounded holes represent the observed surface disturbances caused by a number of unidentified infauna, including burrowing polychaetes, some bivalve species, and mud shrimp.
10. As a group, echinoderms were the most diverse organisms at the site.
11. Orange sea pens were widely distributed throughout the site. Based on a statistical analysis of the data, the highest concentrations of sea pens were found in an area to the SW of Coast Island and another area off the north tip of Coast Island.

12. Dungeness crabs were observed throughout the site. Based on a statistical analysis of the data, the highest concentrations of Dungeness crabs were found off the SE shore of Coast Island, off the north tip of Coast Island, and between the rocky reef and Ridley Island. Two of these areas are closely associated with the regions of highest eelgrass density.
13. Spiny pink shrimp, which were very common at the site, were found in waters of depths greater than 10 m.
14. Fish were found in moderate abundance at this site, mostly at depths greater than 10 m.
15. The following commercial species were observed at the site:
    a. spiny pink shrimp in very high abundance
    b. geoduck clams in high abundance
    c. Dungeness crab in high abundance
    d. spot prawns in moderate abundance
    e. California sea cucumbers in moderate abundance
    f. flatfish in moderate abundance
    g. longnose skates in low abundance
16. The overall Shannon's diversity index for the site was 3.734 and the species richness was 57. By comparison with other local sites, the diversity for this site is quite high.
17. Maximum species richness for the site occurs in three regions: (1) an area along the SW shore of Coast Island; (2) the northern tip of Coast Island; and (3) the area between the rocky reef and Ridley Island. Maximum species diversity is correlated with:
    a. water depth. Shallow, well-lit regions support good algal growth. This, in turn, supports high faunal diversity.
    b. rocky, rugged terrain. Rocky terrain provides many crevices and cracks where organisms can become established, thus increasing faunal diversity.

1 Ridley Island Subtidal Survey Methodology

1.1 Towed Benthic Video Survey Design

1.1.1 Towed Video System

A DGPS-positioned, towed video system was used to collect imagery of the seabed (similar to the Seabed Imaging and Mapping System [SIMS] used by CORI). This system was a custom-built model designed for use in the steep, rugged terrain characteristic of British Columbia fjords. Typical tow speed was 0.8 knots. The towed video system had two video cameras - one in a forward-looking orientation and one in a downward-looking orientation. Both cameras have a Sony 1/3" super HAD color CCD with 480 lines horizontal resolution (768 x 494 pixels) and 0.5 lux @ F 2.0. These cameras provided composite video signals to an overlay unit that stamped the DGPS position data (latitude/longitude), together with date and time, on each video frame. The video signal was also displayed in real-time on the vessel, where it was used to adapt the survey to particular features that were seen while underway. High intensity white LEDs were mounted on the camera to provide additional illumination when it was required.

The altitude of the underwater camera was controlled using a hydraulic winch which was operated from the bridge while monitoring the real-time video feed from the camera. Typically, the camera was towed approximately 1 m above the seabed.

1.1.2 Video Recording System

The dual analog camera signals were recorded using a digital video recorder directly onto a hard drive. After the survey was completed, the raw video data was copied onto DVDs. As the digital video recorder creates video files in a proprietary format, software to view and convert the video data into other formats was also provided on each raw video DVD.

1.1.3 Survey Design

The data for this report comes from two benthic video surveys of the Canpotex site - the first completed during the period January 20th to January 21st, 2009, and the second completed during the period May 18th to May 20th, 2009. For both surveys, the nominal shore-normal and shore-parallel transect line spacing was 160 m (Figure 1). All shore-normal survey track-lines were continued inshore to about 2 m water depth or to the limit of safe navigation. Surveys were carried out in waters up to 60 m depth.

1.2 Classification and Mapping

1.2.1 Database of Species and Substrate Classifications

Raw video of the transects was reviewed and classified using a substrate and biotic classification similar to that used by the British Columbia Land Use Coordination Office (LUCO). A data record of substrate and biota classes was produced for each second of video imagery.

The geology database contains information on substrate type (Table A1 in the Appendix) and percentage substrate cover (Table A2 in the Appendix). Anthropogenic features were mapped as part of the geological inventory.

The biological database captured detail on seabed biota within two general categories, vegetation (Table A3 in the Appendix) and fauna (Table A5 in the Appendix). Up to three faunal and floral types were evaluated for each second of video and given distribution codes. Vegetation coverage classes (Table A4 in the Appendix) and faunal distribution classes (Table A6 in the Appendix) were also recorded. Note that very small species (e.g., barnacles, small tube worms, small algal species), infauna (e.g., clams), cryptic fauna (e.g., flatfish, decorator crabs), or hidden fauna (e.g., under kelp fronds) were often not identified in the video footage, and were therefore not included in the database.

Video annotation created a linked, random-access database of all the video data which can be readily searched using keywords from the classification scheme. Additionally, the provided “Transect Player” software links video and GPS data, allowing simultaneous viewing of the camera’s geographical position on a map and the video images captured by the camera at that location.

All classification data was also entered into a relational Access database, which was then used to generate the data for mapping. This database contains a “Filter by Video” function which allows the user to browse through the data for each transect as a series of data recording forms.

1.2.2 ArcGIS Mapping

Maps of observed species distribution and estimated species ranges were produced using ArcGIS. These maps have been provided as an ArcGIS project which can be viewed using the supplied ArcReader.

1.2.3 Survey Confidence Levels

All transect cross-over points were used to determine the confidence levels in the interpretation of the image data. All the data records within a 5.0 m radius (the maximum positional error of a DGPS signal) of the location where two transect lines crossed were analyzed for similarities. The number of times that data records from both transect lines had the same values for each classification category (e.g., substrate, vegetation, fauna) was recorded and used to generate percentage confidence.

1.2.4 Substrate Maps

Substrate observations were mapped as a series of points in ArcMap. A hexagonal grid (composed of hexagonal polygons with widths of 40 m) was overlaid on the observation points. Each polygon was assigned a substrate code based on the code of the majority of the data points, weighted by percentage cover, within that polygon. Polygons which contained no data points were assigned the code of the nearest neighbouring polygon.

1.2.5 Range Maps

Range maps for flora and fauna were generated using the fixed kernel density estimation procedure. Flora observations were weighted by abundance (see Table A4 in the Appendix) and fauna observations were weighted by distribution (see Table A6 in the Appendix). In order to allow overlap of polygons between transects, the search radius (a.k.a. the smoothing factor) was set to the distance between transects (e.g., 160 m). For each organism, a 95% volume contour was generated. This consisted of a polygon covering a geographical area in which 95% of the estimated population was expected to be found.

1.2.6 Dominant Species Maps

Species observations for both flora and fauna were mapped as a series of points in ArcMap. A hexagonal grid (composed of hexagonal polygons with widths of 40 m) was overlaid on the observation points. Each polygon was assigned a species code based on the most abundant species within that polygon, weighted by abundance (for flora) or distribution (for fauna). Polygons which contained no data points were assigned the code of the nearest neighbouring polygon.

1.2.7 Minor Species Maps

Species observations for both flora and fauna were mapped as a series of points in ArcMap. A hexagonal grid (composed of hexagonal polygons with widths of 40 m) was overlaid on the observation points. Each polygon was assigned a species code based on the code of least abundant species within that polygon, weighted by abundance (for flora) or distribution (for fauna). Polygons which contained no data points were assigned the code of the nearest neighbouring polygon.

1.2.8 Diversity Analysis Using Range Maps

Calculations of Shannon's diversity index, Shannon's evenness, and Simpson's dominance index were carried out in ArcMap using the range map polygons. Note that the diversity values generated from the range map data should be considered minimum values for the site, as very small species (e.g., barnacles, small tube worms), infauna (e.g., clams), cryptic fauna (e.g., flatfish, decorator crabs), or hidden fauna (e.g., under kelp fronds) are often not identified in the video footage, and are therefore may not included in the diversity calculations.

1.2.9 Species Richness Maps

A hexagonal grid (composed of hexagonal polygons with widths of 40 m) was overlaid on a shape file containing all the range map polygons for a particular category (e.g., flora, fauna, total species). Using polygon in polygon analysis, each hexagonal polygon was assigned a number equal to the number of range map polygons with which it overlapped. This assigned number was equal to the species richness in a given hexagonal polygon, since each range map polygon represented a different species. The coded hexagonal polygons were used to generate a species richness map.

2 Ridley Island Subtidal Survey Results

2.1 Benthic Video Survey

The transect lines for the survey as carried out are shown in Figure 2. Coverage for the site was excellent, with good extension of the transects to the edges of the proposed survey boundary. Other factors which had an effect on the survey quality and resolution were:

1. ***kelp*** - kelp beds limited access to shallow regions of the site. Fringing kelp beds along the islands and submerged rock reefs at the site (see Figure 10) made access to these areas impossible due to restrictions associated with operating the boat and gear safely within the kelp beds.
2. ***turbid water*** – the site is located directly in the plume of the Skeena River (see Figure 3), resulting in normally high turbidity. As a result, the visibility at the site seldom exceeded 1 m. High intensity LEDs were used to provide light during the video runs; however back-scattering of light from the silt particles often created a "halo effect", causing additional visibility issues. This reduced the resolution of the video camera, producing a grainy image quality. In spite of these problems, the image quality was deemed sufficient for organism identification. Due to the limited visibility, the camera was often towed less than 1 m above the bottom, resulting in a relatively small field of view and a low towing speed (0.5 knots).
3. ***strong currents*** – strong currents occasionally made course-holding difficult on a few of the transects.
4. ***seasonal differences*** – some of the transect data was collected during the winter, while other data was collected during the spring. There may have been seasonal differences in the abundances of motile organisms, such as fish, crabs, prawns, and shrimp.

Five DVDs of raw video data were generated from the survey. Processing and annotation of the video data produced three DVDs containing the clipped and converted videos and viewers to visualize the data.

2.2 Survey Confidence Levels

A total of 84 cross-over points were used to determine the survey confidence levels (refer to the "Cross over points" layer in the attached ArcGIS project). Each pair of records was compared for:

1. substrate
2. fauna
3. flora

The results of this analysis are given in Table 1.

Table 1. Confidence levels in data interpretation.

Category	# Points Compared	# Points in Agreement	% Confidence
Substrate	84	81	96
Flora	84	77	92
Fauna	84	75	89
Overall	**252**	**233**	**92**

The overall confidence level of 92% is very good. In regions where the substrate was changing (e.g., from sand to silt-mud), poor visibility made substrate interpretation more subjective, resulting in lower confidence levels in assignment of substrate type in these regions.

There was some difficulty in differentiating between the various species of soft brown kelps present at the site, particularly when visibility was poor, and this may have led to a slight decrease in the confidence levels for assignment of flora.

Lower confidence levels in assignment of fauna are expected, as fauna are mobile and may have moved out of the cross-over area between transects.

2.3 Substrate

Based on video observations, the site substrate consisted largely of silt-mud, with some shell, wood, and organic debris (see Figure 4). Bedrock occurred around Coast Island, the reef to the NE of Coast Island, and Bacon Rock. Sand was present along the shore or Ridley Island, and to a lesser extent, around Coast Island and the reef to the NE of Coast Island.

A significant wave and current shadow (e.g., tombolo effect) occurred behind Coast Island. This resulted in the deposition of large amounts of organic debris (seaweed wrack) between Coast Island and Ridley Island (see Figure 5).

Commercial crab harvesting operations took place at the site throughout the duration of the survey. The presence of crab gear on the seafloor was observed frequently in the video footage (see Figure 6). Crabs were also observed in and around commercial crab traps (see Figure 7).

Anthropogenically-produced garbage was observed in moderate amounts at the site (see Figure 8). As with the organic debris, much of this garbage was trapped in the current shadow region behind Coast Island.

2.4 Flora

In many of the shallow areas around Coast Island and the reef to the NE of Coast Island, vegetation dominated the benthic environment. Vegetation was less dominant along the Ridley Island shoreline; however, significant amounts of eelgrass were present.

Algal abundance declined as one moved away from the shallow water regions as a result of the rapid decrease in light in the offshore direction. Due to the extreme turbidity, which reduced light for photosynthesis, and the heavy siltation, which rapidly covered nonmotile organisms, the algal abundance in the offshore regions of the site was low.

Table 2 lists the various groups of flora identified at the site, and their abundances in terms of both total number of observations and percentage of total flora abundance by area based on the range maps for each group.

Table 2. Abundances of various flora groups.

Flora identification	Number of Observations	% of Total Flora Abundance by Area
Sugar wrack kelp	2863	9.72
Filamentous reds	2169	8.21
Fringed sea colander kelp	914	7.56
Foliose reds	868	9.35
Eelgrass	774	4.61
Suction-cup kelp	707	6.01
Nereocystis	453	9.62
Coralline reds	322	6.85
Stringy acid weed	98	6.55
Alaria	96	7.00
Foliose greens	81	7.78
Split kelp	40	3.24
Broad acid weed	38	6.88
Filamentous greens	19	5.38
Seersucker kelp	10	1.23

Some observations regarding flora at the Canpotex site are:

1. The greatest algal abundance at the site occurred along the small stretch of Ridley Island shoreline that was mapped, and around Coast Island and the rocky reef to the NE of Coast Island. These regions were shallow, and had some amount of either rock or cobble substrate present. The combination of greater light penetration and harder substrate for algal holdfasts made these areas better sites for algal growth.
2. The most dominant alga in terms of both number of observations and area was sugar wrack kelp.
3. Green seaweeds occurred mainly in the region between Coast Island and Ridley Island. Foliose greens were more abundant and widely dispersed than filamentous greens (see Figure 9).
4. Surface beds of bull kelp (*Nereocystis*) were observed on the west side of Coast Island, and associated with the rocky reef to the NE of Coast Island (see Figure 10). Benthic videography was not carried out in these beds due to potential entanglement of gear and shallow water. Some subsurface *Nereocystis* was observed in the video footage from the east side of Coast Island and the shoreline of Ridley Island. The surface and subsurface observations of *Nereocystis* were combined to generate a range map for *Nereocystis* (see Figure 11). Based on a statistical analysis of the data, the highest concentrations of *Nereocystis* were found around the rocky reef to the NE of Coast Island, at the northern tip of Coast Island, and along the SW shore of Coast Island (see Figure 12).
5. Three species of *Laminaria* were observed at the site: *Laminaria setchellii* (split kelp), *Laminaria saccharina* (sugar wrack kelp), and *Laminaria yezoensis* (suction-cup kelp) (see Figure 13). Sugar wrack kelp was the most abundant of the three species, and was widely dispersed around Coast Island and the reef to the NE of Coast Island. Suction-cup kelp was locally abundant at specific regions within the site (north and south tips of Coast Island, the rocky reef to the NE of Coast Island, and at one location along the Ridley Island shoreline). Split kelp only occurred at the north end of Coast Island and around the rocky reef to the NE of Coast Island.
6. Three other kelp species also occurred at the Canpotex site: *Costaria costata* (seersucker kelp), *Agarum fimbriatum* (fringed sea colander kelp), and *Alaria* sp. (see Figure 14). Fringed sea colander kelp was the most widely dispersed of these three, and occurred around Coast Island and the reef to the NE of Coast Island. *Alaria* only occurred in the region between Coast Island and Ridley Island, and seersucker kelp was only observed on the reef to the NE of Coast Island.
7. Two species of *Desmarestia* were observed at the site: *Desmarestia viridis* (stringy acid weed) and *Desmarestia lingulata* (broad acid weed) (see Figure 15). Both species occurred along the eastern shore of Coast Island, around the rocky reef to the NE of Coast Island, and along the shoreline of Ridley Island.
8. Foliose, filamentous, and coralline red algae were all observed at the Canpotex site (see Figure 16). Foliose reds were the most areally dispersed of the three groups; however, filamentous reds were the most abundant in terms of numbers of observations. Coralline reds occurred at specific locations in the sites where exposed bedrock was present (north tip of Coast Island, SW shore of Coast Island, and the rocky reef to the NE of Coast Island).
9. Eelgrass was found along the SE shore of Coast Island, and in a strip along the section of Ridley Island shore that was surveyed (see Figure 17). While present, the eelgrass beds were relatively sparse in nature, seldom exceeding 75% cover. Based on a statistical analysis of the data, the highest concentrations of eelgrass were found in a small area along the SE shore of Coast Island and in a patch along the northern section of the Ridley Island shoreline (see Figure 18).

2.5 Fauna

Table 3 lists the various groups of fauna identified at the site, and their abundances in terms of both total number of observations and percentage of total fauna abundance by area based on the range maps for each group.

Table 3. Abundances of various fauna groups.

Fauna identification	Number of Observations	% of Total Fauna Abundance by Area
Unmounded hole	47084	12.40
Spiny pink shrimp	4717	2.51
Orange sea pen	1967	6.74
Bryozoan complex	914	2.63
Geoduck clam	550	7.92
Sunflower seastar	178	6.38
Dungeness crab	106	7.73
Red sea cucumber	85	2.23
Northern ronquil	44	2.17
Plumose anemone	44	4.36
Spot prawn	38	2.89
Unidentified eelpout	33	1.40
False ochre seastar	31	2.40
California sea cucumber	29	2.45
Short-spined seastar	27	1.94
Unidentified flatfish	27	2.63
Bacterial mat	23	1.83
Unidentified sculpin	21	2.14
Parchment tube worm	18	2.42
Stalked vase sponge	17	1.33
Painted star	16	2.48
Calcareous tube worm	13	1.10
Ochre seastar	12	2.28
Decorator crab	11	1.85
Vermilion star	11	1.57
Longnose skate	10	1.61
Snake lock anemone	10	1.33
Unidentified fish	10	2.00
Long ray star	9	1.53
Spiny mudstar	8	1.26
California lamp shell	6	0.41
Dogwinkle	6	1.22
Mounded hole	4	0.76
Solaster sp.	4	0.81
Pacific lugworm	3	0.41
Henricia sp.	2	0.41
Unidentified pandalid	2	0.41
Unidentified tunicate	2	0.41
Black-eyed goby	1	0.41
Gray brittle star	1	0.41
Moon jellyfish	1	0.41
Unidentified crab	1	0.41

Some observations regarding fauna at the Canpotex site are:

1. The most dominant fauna in terms of both number of observations and area were unmounded holes. Unmounded holes represent the observed surface disturbances caused by a number of unidentified infauna, including burrowing polychaetes, some bivalve species, and mud shrimp.
2. As a group, echinoderms were the most diverse organisms at the site.
3. The following distribution patterns were observed for organisms for which there were more than 4 sitings:

a. In several areas around the southern region of the site, yellow to orange colored bacterial mats were observed on the silt-mud sediment surface (see Figure 19). These were probably regions where sulphuretums (ecosystems in which bacteria convert sulfur into different chemical forms, such as sulfate) were active. Rapid breakdown of woody debris in a low oxygen environment can result in the production of hydrogen sulfide, a condition which can favor the formation of sulphuretums.
b. Stalked vase sponges occurred in shallow water on the western side of Coast Island (see Figure 20).
c. Plumose anemones were found throughout the site wherever suitable substrate occurred (see Figure 21). They were typically associated with bedrock, or with cobble and pieces of woody debris on an otherwise silt-mud substrate. Snake lock anemones tended to occur in and around Coast Island and the rocky reef to the NE of Coast Island (see Figure 21).
d. Orange sea pens were widely distributed throughout the site (see Figure 22). The majority of the population consisted of small (probably less than 10 cm tall) individuals which were found to the west of Coast Island. These individual most likely resulted from a recent spawn of sea pens. Larger individuals were located between Coast Island and Ridley Island. Based on a statistical analysis of the data, the highest concentrations of sea pens were found in an area to the SW of Coast Island and another area off the north tip of Coast Island (see Figure 23).
e. A few dogwinkles were observed (see Figure 24). They were mainly found on a silt-mud to sand substrate.
f. Unmounded holes were found in high abundance throughout the site (see Figure 25). These holes probably represented a variety of infaunal organisms; however most cannot be accurately identified from video images. In some cases, the larger clams, such as geoducks, can be identified by their characteristic siphon hole pattern and occasional sitings of the actual siphons. Where identification was possible, geoducks were generally observed in waters of depths less than 20 m (see Figure 25). Many other clam species were probably also present throughout the site, as indicated by the presence of empty shells on the surface of the substrate.
g. Parchment tube worms were mainly found on the west side of Coast Island and around the rocky reef to the NE of Coast Island (see Figure 26). This grouping probably represented more than one species, as the tube worms were observed both in mud-silt substrate and on bedrock. Calcareous tube worms were observed on exposed bedrock in several regions of the site (SW shore of Coast Island, north tip of Coast Island, and around the reef to the NE of Coast Island) (see Figure 26).
h. A “bryozoan complex”, consisting of byrozoans, hydroids, sponges, and other encrusting fauna, was present on exposed rocks in shallow water on the west side of Coast Island, around the reef to the NE of Coast Island, and in the Bacon Rock area (see Figure 27).
i. A few California lamp shells were observed in the rocky reef area to the NE of Coast Island (see Figure 28).
j. Decorator crabs were observed in association with seaweed, either in living and attached seaweed around Coast Island and the reef to the NE of Coast Island, or in patches of seaweed drift between Coast Island and Ridley Island (see Figure 29). Dungeness crabs were observed throughout the site (see Figure 29). Based on a statistical analysis of the data, the highest concentrations of Dungeness crabs were found off the SE shore of Coast Island, off the north tip of Coast Island, and between the rocky reef and Ridley Island (see Figure 30). Interestingly, two of these areas (off the SE shore of Coast Island and between the rocky reef and Ridley Island) are closely associated with the regions of highest eelgrass density.

k. Second only to unmounded holes in abundance, spiny pink shrimp were very common at the site. They were found only in waters of depths greater than 10 m. Also found in the same regions, but at a much lower abundance, were spot prawns (see Figure 31). While overlapping in range with spiny pink shrimp, spot prawns also occurred in somewhat deeper waters as well. The majority of shrimp and prawn sitings came from transects which were carried out during the January video survey. This may be the result of seasonal variations in shrimp and prawn abundance.
l. Seastars were abundant and widely dispersed throughout the site, without any particular patterns of distribution (see Figure 32 and Figure 33). Sunflower seastars were the most abundant seastars at the site. Most of the seastars were observed in waters of less than 10 m depth.
m. Both California sea cucumbers and red sea cucumbers were seen in areas around Coast Island and the rocky reef to the NE of Coast Island. Additionally, California sea cucumbers were observed in the area around Bacon Rock (see Figure 34). Red sea cucumbers were more abundant at the site than California sea cucumbers.
n. In general, fish were found in moderate abundance at this site (see Figure 35). The most common fish were Northern ronquils, eelpouts, and flatfish. The majority of fish were found in waters of depths greater than 10 m. The longnose skate distribution was somewhat reflective of the Dungeness crab distribution, and it was probable that the skates were in the area feeding on the crab population.

4. The following commercial species were observed at the site:
    a. spiny pink shrimp in very high abundance
    b. geoduck clams in high abundance
    c. Dungeness crab in high abundance
    d. spot prawns in moderate abundance
    e. California sea cucumbers in moderate abundance
    f. flatfish in moderate abundance
    g. longnose skates in low abundance

2.6 Diversity Analyses

2.6.1 Dominant and Minor Vegetation Analyses

Analysis of vegetation species dominance shows that the most dominant specie at the site was sugar wrack kelp (see Figure 36). However, foliose red algae and eelgrass were also very abundant. In considering the entire site, flora diversity in shallow water is very high, whereas flora diversity in deeper water is very low due to high turbidity and low light conditions. The map of minor vegetation species also shows very high diversity in shallow water, with 13 species more or less equally distributed throughout this region (see Figure 37). It should be noted that many of the smaller seaweed species cannot be identified using a video camera (they often require the use of a microscope for accurate identification), and thus the actual flora diversity of the site is probably somewhat higher. The diversity in each individual polygon is quite high. In the areas where algae occurred, only 20% of the individual polygons showed no diversity (e.g., contained only one species).

2.6.2 Dominant and Minor Fauna Analyses

Analysis of fauna species dominance shows that unmounded holes are clearly the most dominant fauna overall (see Figure 38). However, spiny pink shrimp are more dominant in deeper waters, and the “bryozoans complex” is more dominant in rocky habitats. In considering the entire site, fauna diversity is moderately high, as shown in the map of minor species (see Figure 39). Note, however, that unmounded holes and spiny pink shrimp are still present as the least abundant species in a number of polygons. Again, very small species (e.g., barnacles, small tube worms), infauna (e.g., clams), cryptic fauna (e.g., flatfish, decorator crabs), or hidden fauna (e.g., under kelp fronds) often cannot be identified in the video footage, and thus the actual fauna diversity of the site is probably higher than observed. The diversity in each individual polygon is moderately high. For fauna, only 26% of the individual polygons showed no diversity.

2.6.3 Diversity Indices

The overall Shannon’s diversity index for the site was 3.734, and the species richness was 57. By comparison, if all organisms in the site were completely evenly distributed (which would generate a maximum value for Shannon’s diversity index), the maximum possible diversity for the site with a species richness of 57 would be 4.043. This suggests that the particular complement of species at this site are moderately close to reaching their maximum diversity. The Shannon’s evenness value of 0.924 also indicates that the species are relatively evenly distributed throughout the site (a value of 1.0 would indicate a completely even distribution).

To determine how the diversity of this site ranks with other sites in the area, we need to have some comparative values for species richness. Dr. Shannon Bard has provided information on species richness for a number of sites in the Prince Rupert area on her website (http://www.ecotoxicology.ca/csi/Prince%20Rupert.html). Her data indicates that recent values for species richness (2003) range from approximately 38 to approximately 60. Using these two values of species richness, we can calculate a range for the maximum value of Shannon’s diversity index for the area from 3.638 to 4.094. By comparison, the value of 4.043 for this site is quite high (i.e., it has a relative richness of 95% using a maximum potential species richness of 60).

The site has a Simpson’s dominance index of 0.309. The Simpson’s dominance index approaches 1.0 as one particular species dominates the site. A value of 0.309 suggests that there is some dominance by organisms (particularly unmounded holes and spiny pink shrimp) at the site, but no extreme dominance (e.g., there are very few locations at the site where only one species is found).

Figure 40 shows the species richness map for the site. Species richness in each hexagonal polygon ranges from 0 to 35. Maximum species richness for the site occurs in three regions: (1) an area along the SW shore of Coast Island; (2) the northern tip of Coast Island; and (3) the area between the rocky reef and Ridley Island. Maximum species diversity is correlated with

1. ***water depth*** - shallow, well-lit regions support good algal growth. This, in turn, supports high faunal diversity.
2. ***rocky, rugged terrain*** - rocky terrain provides many crevices and cracks where organisms can become established, thus increasing faunal diversity.

2.7 Project Deliverables

In addition to this report, the following materials have also been provided from the subtidal survey:

1. Five DVDs containing raw georeferenced seabed video imagery* (overlaid with time, latitude, and longitude) of the survey site.
2. One CD containing:
    a. a georeferenced, classified Access database* for biological and physical features of the seabed.
    b. an electronic ArcGIS project* containing maps of analyzed video data.
    c. a report describing and explaining the results of the video survey.
3. Three DVDs containing:
    a. java-based software which links video* and GPS data, allowing simultaneous viewing of the camera's geographical position on a map and the video images captured by the camera at that location.
    b. a library of video* annotations

*Note: time on the video imagery, in the database, and in the ArcGIS project is given in PST (Pacific Standard Time).

3 Figures

Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

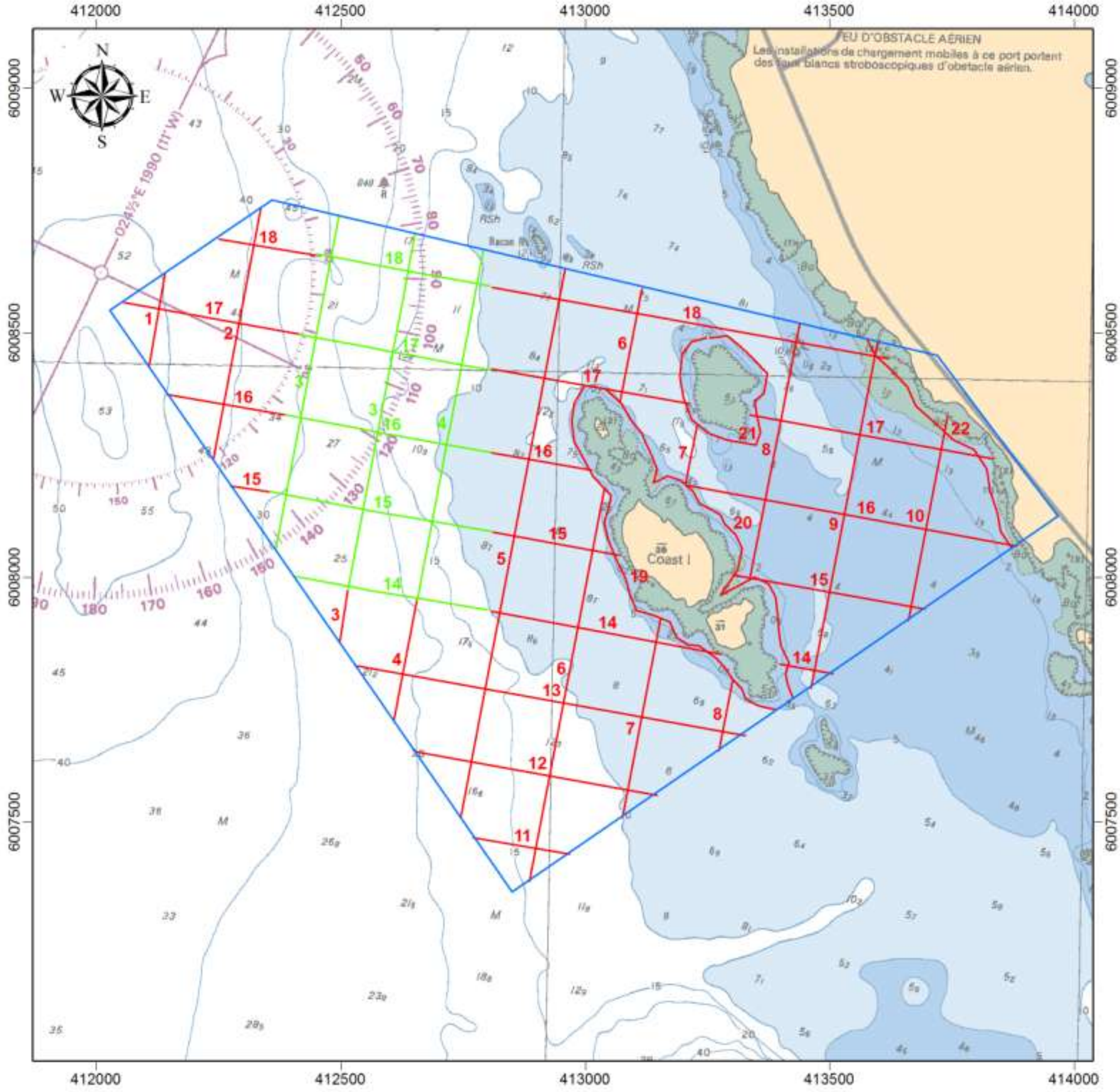


Figure 1.
Survey design showing transects.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

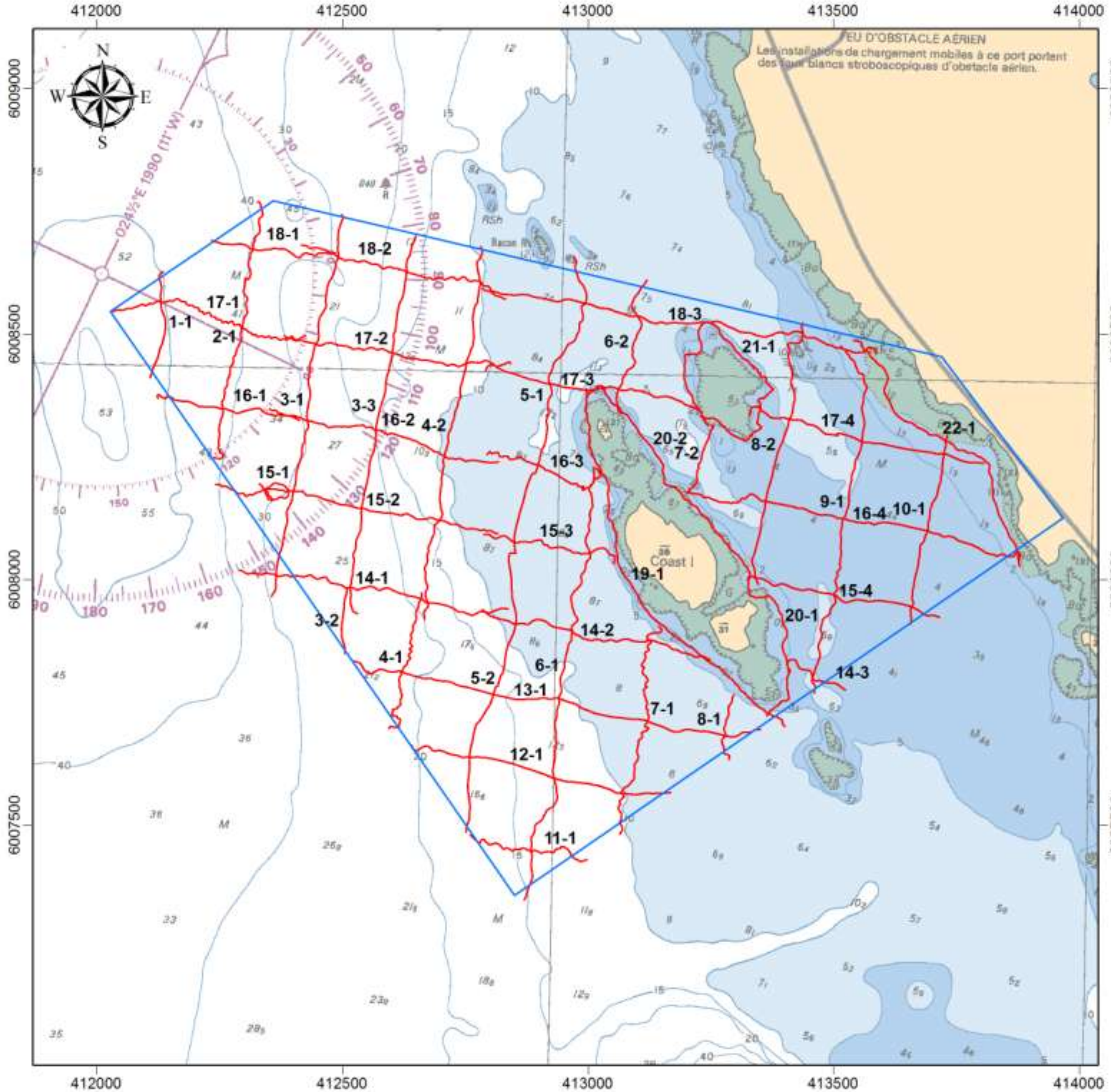
Scale: 1:11,000

Legend

- Survey transects - May
- Survey transects - January
- Survey boundary

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 2.
Completed survey showing transects.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

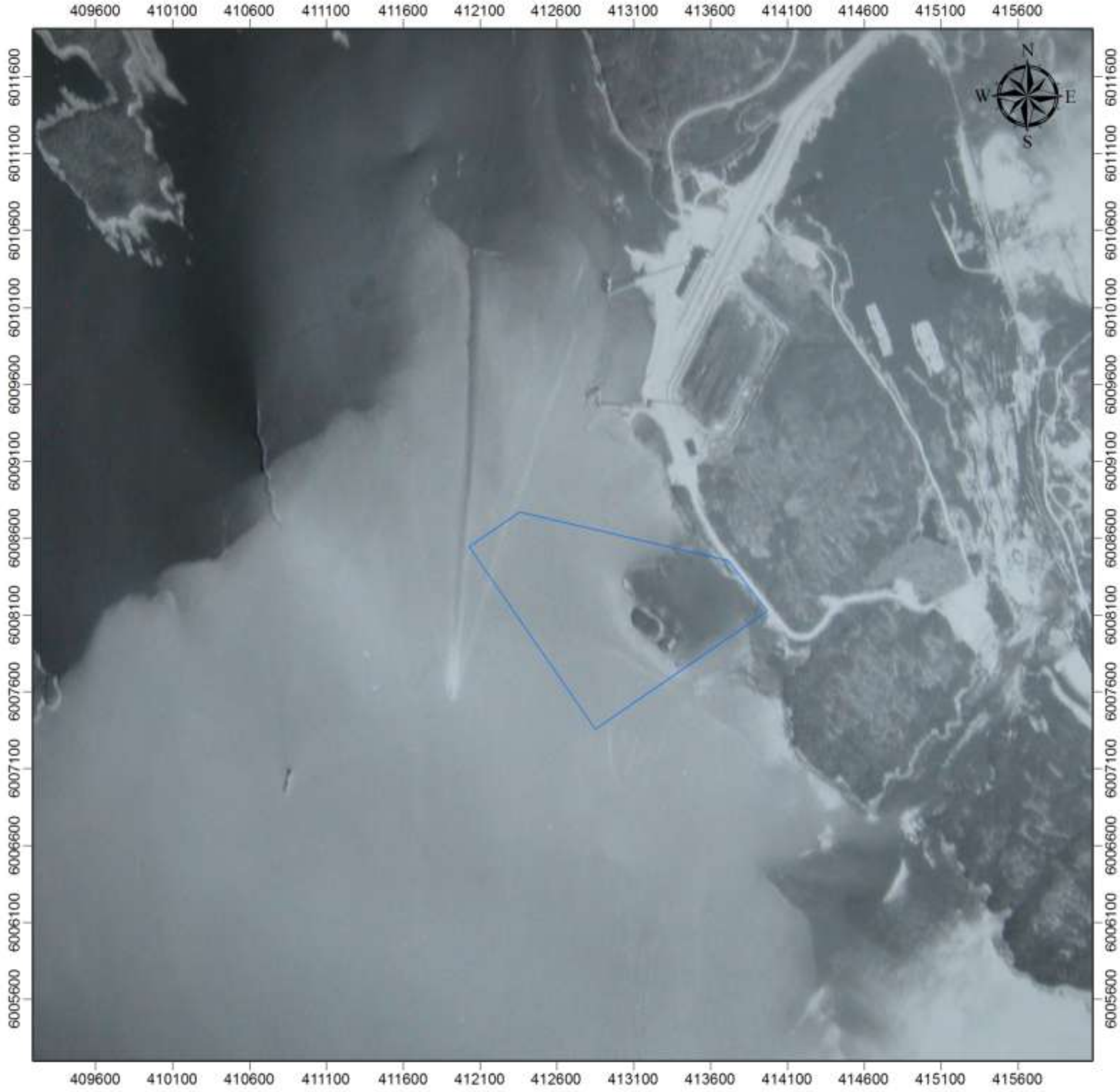
Legend

Survey boundary

Transect lines

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey

Figure 3.
Aerial photograph of the Skeena River plume in relation to the site boundaries.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid
(shore-normal and shore-parallel).

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

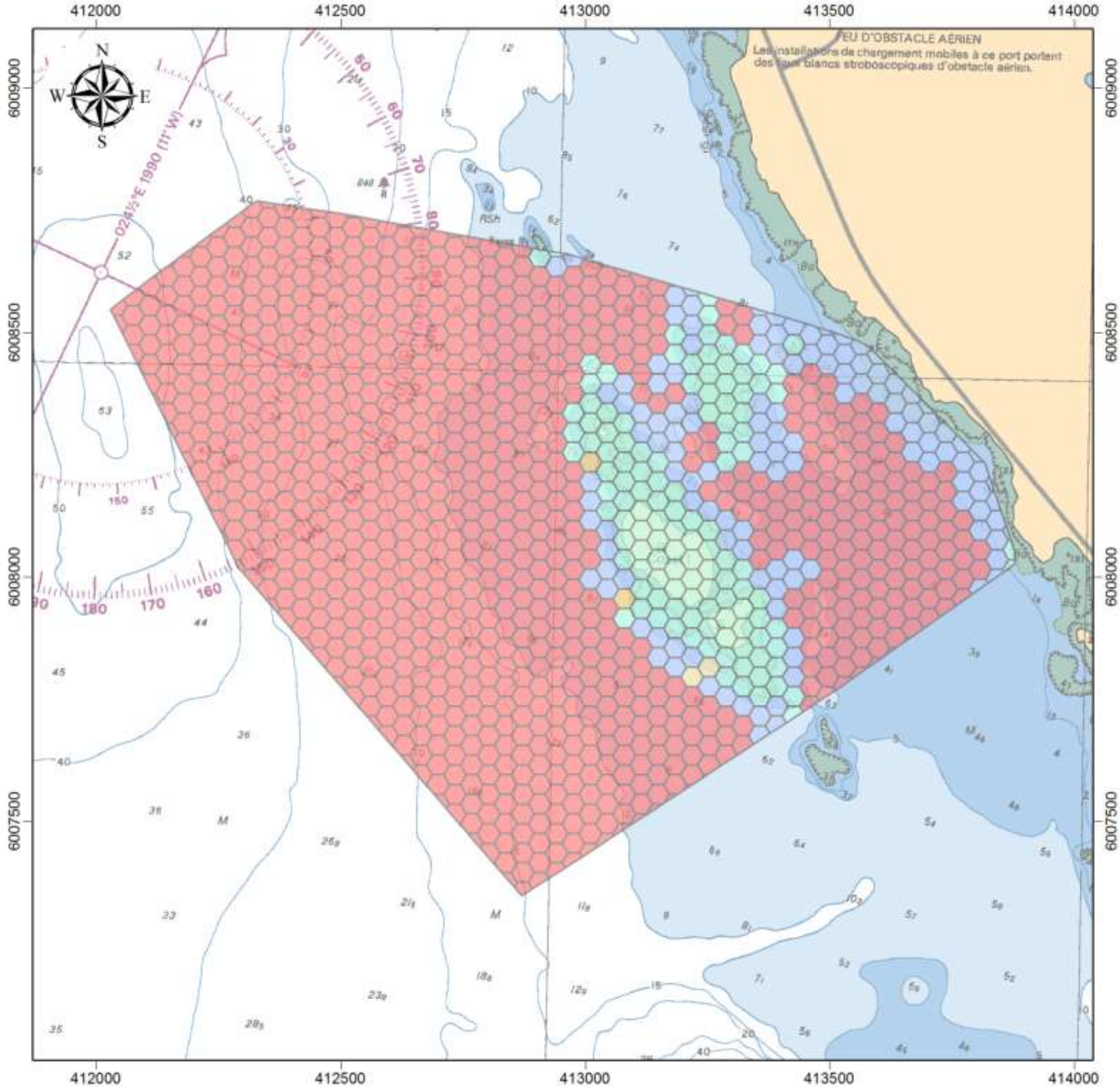
Scale: 1:35,000

Legend

Survey boundary

0 250 500 1,000 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 4.
Substrate map.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

Scale: 1:11,000

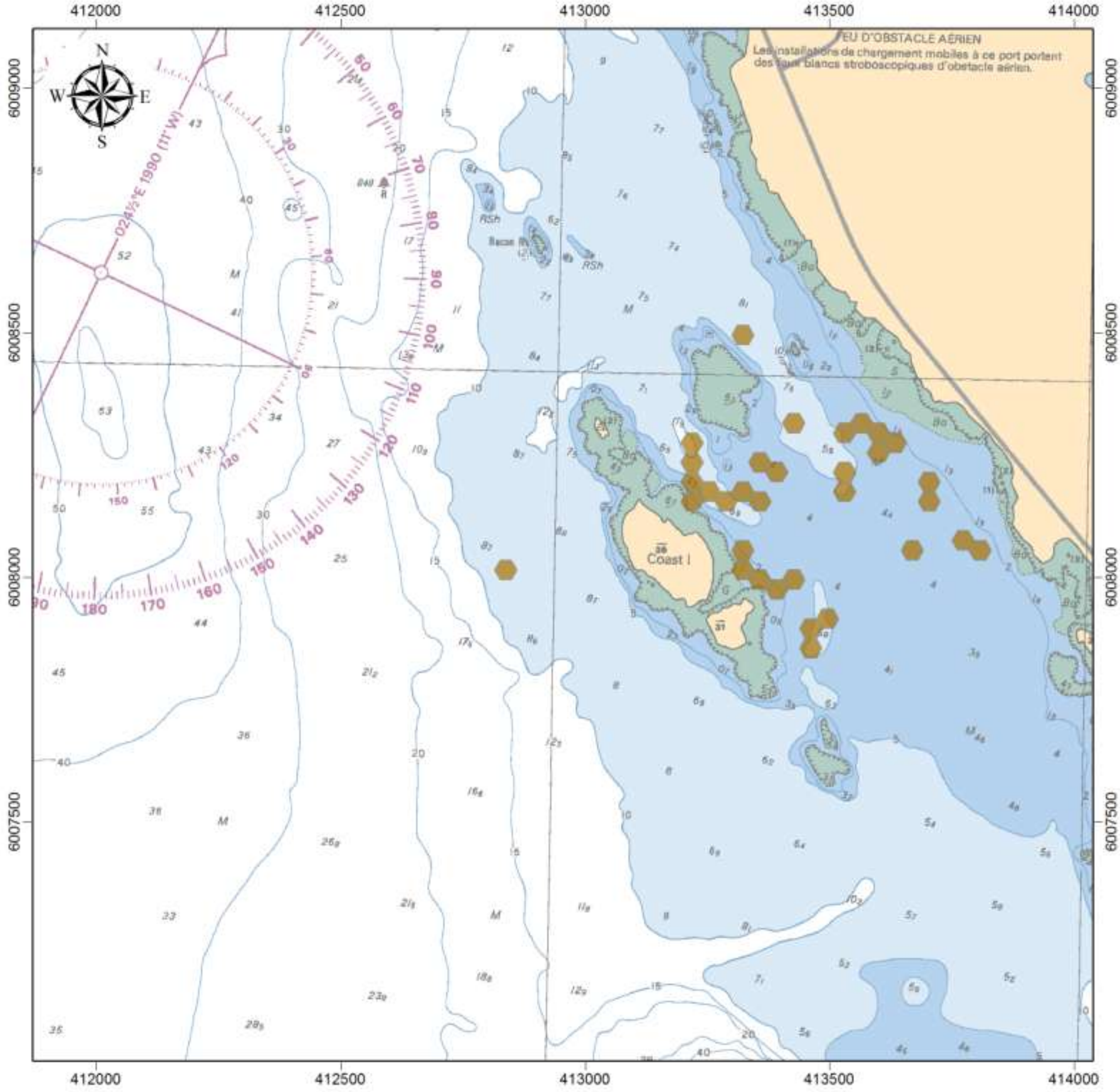
Legend

Dominant substrate map

- Cobble
- Rock
- Sand
- Silt-mud
- Veneer over bedrock

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 5.
Map of deposition of organic seaweed wrack.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

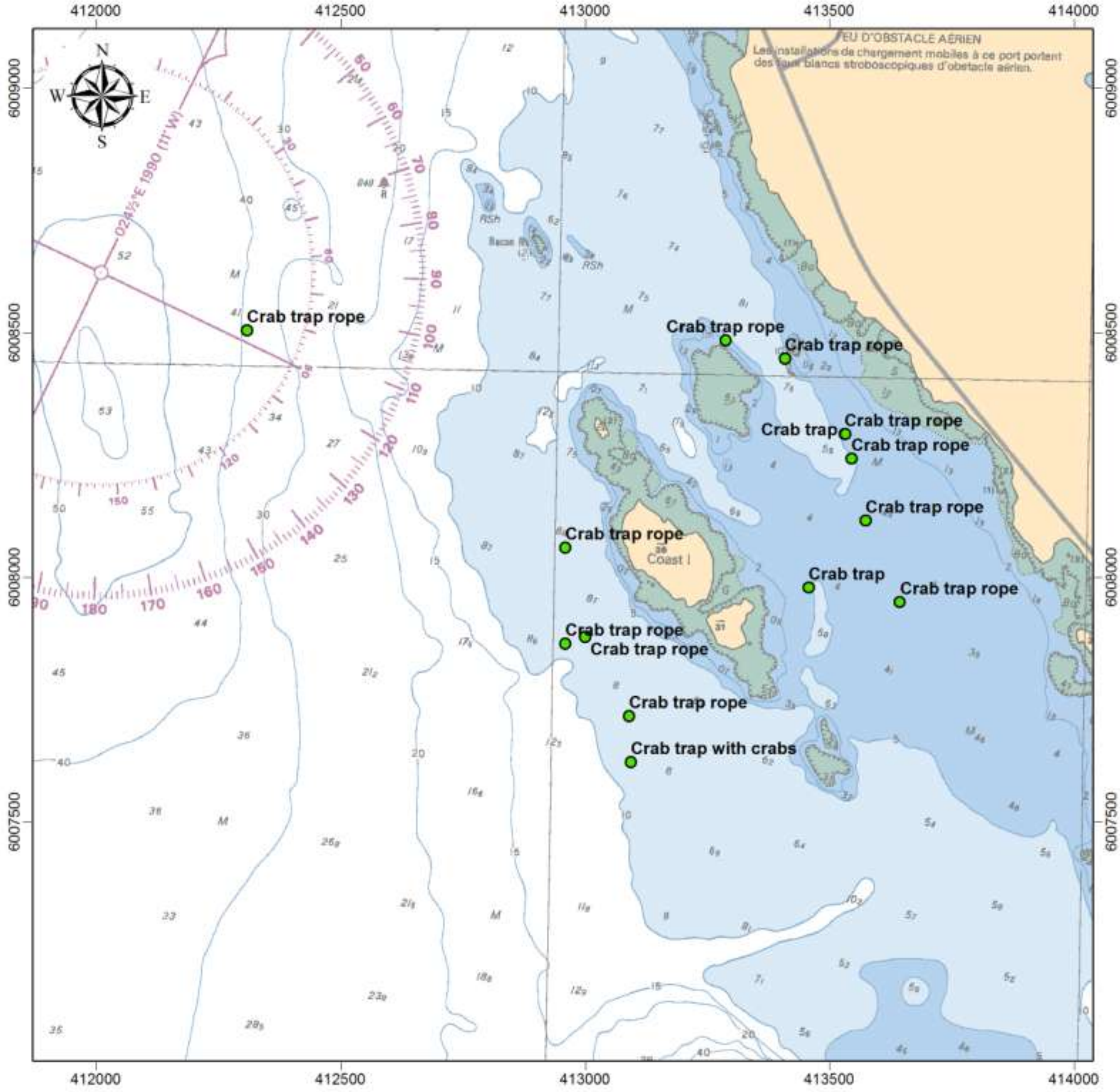
Seaweed wrack

0 62.5 125 250 Meters

OCEAN ECOLOGY

Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 6.
Map of observations of commercial crab gear.



Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

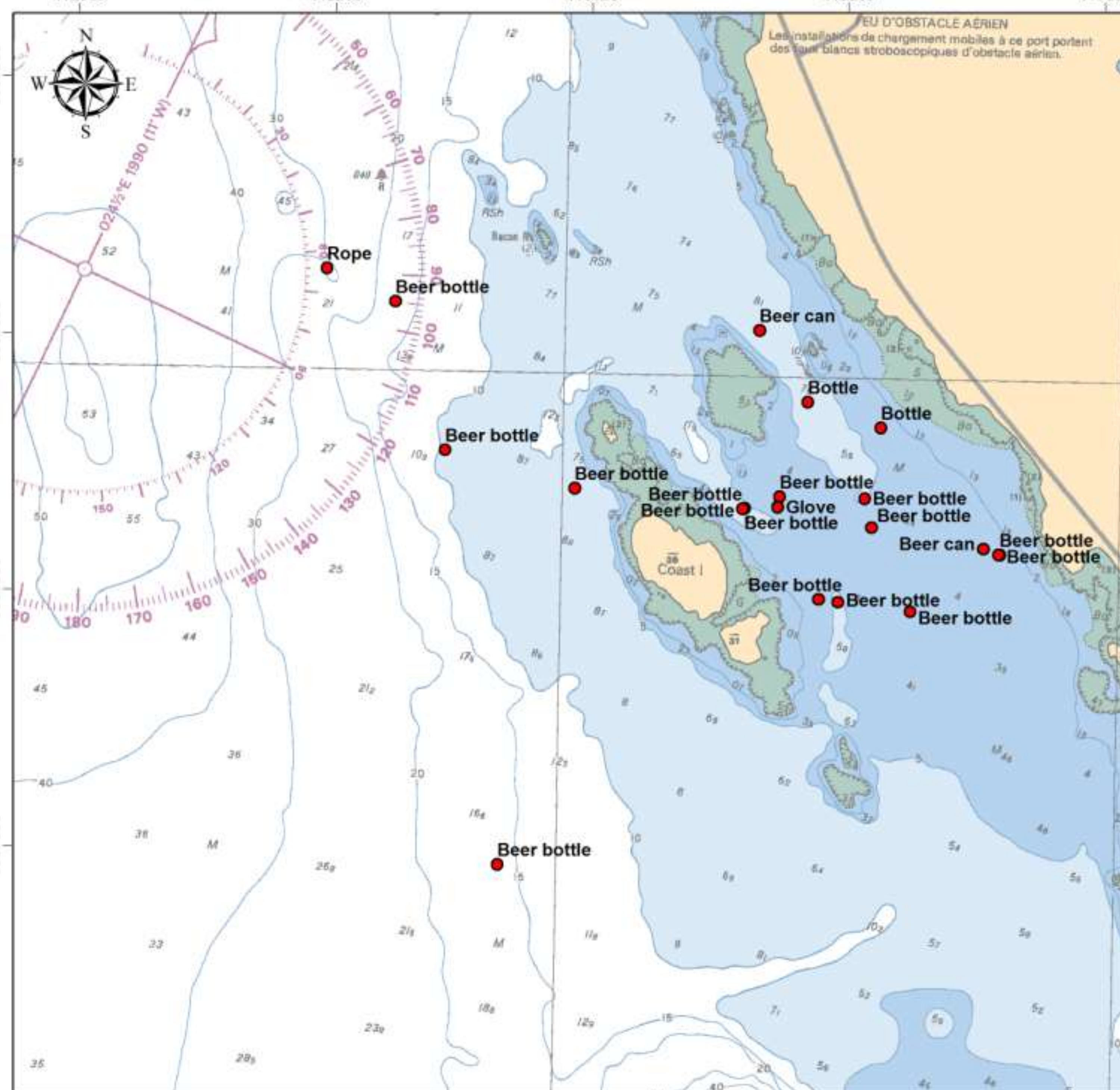
Legend

Anthropogenic - crabbing

0 62.5 125 250 Meters

OCEAN ECOLOGY

Figure 7. Video image of crabs caught in a commercial crab trap at the Canpotex site.



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 8.
Map of observations of anthropogenic garbage.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

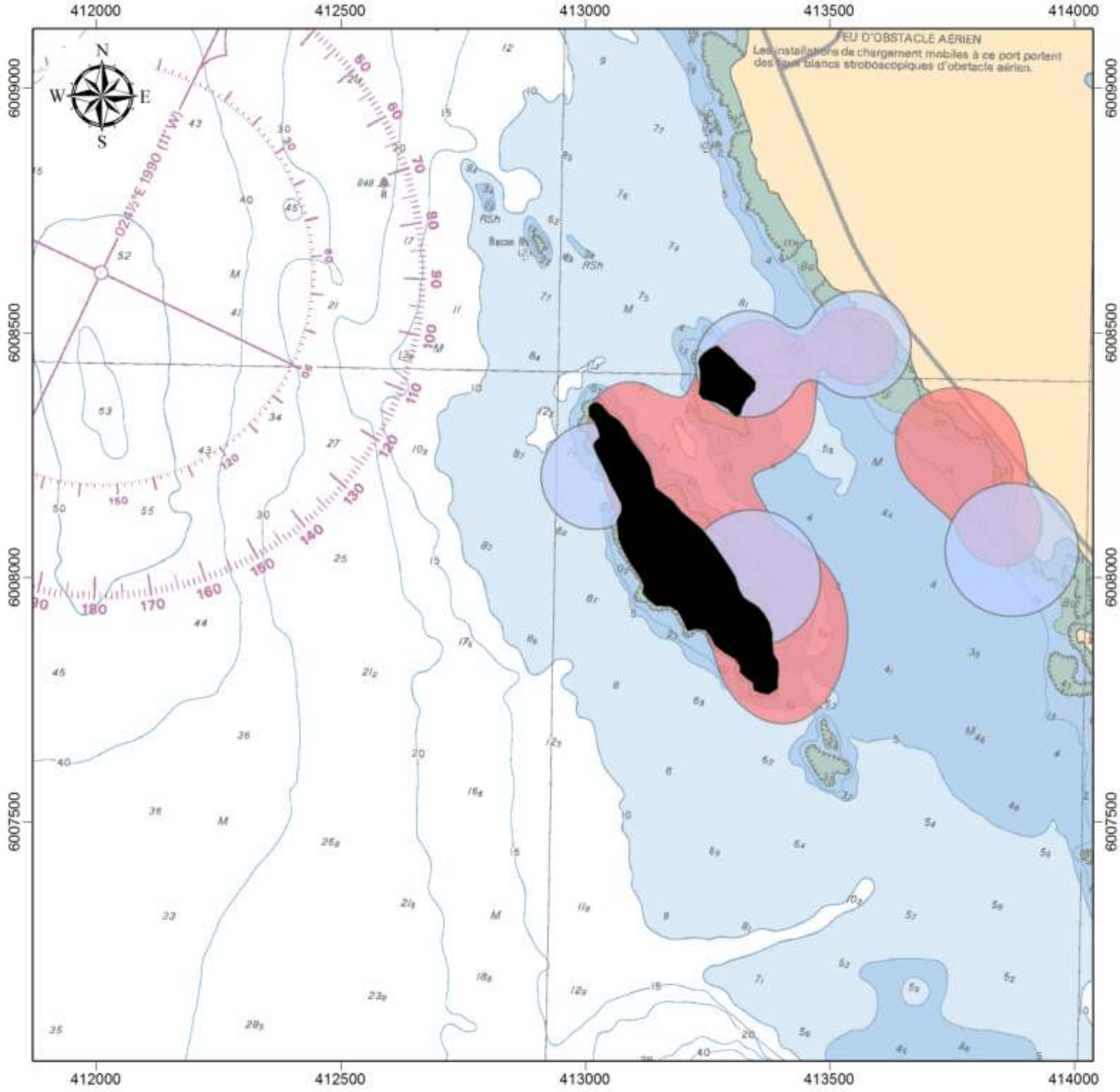
Scale: 1:11,000

Legend

● Anthropogenic - garbage

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 9.
Range map for green seaweeds.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

- Rock mask
- Foliose greens
- Filamentous greens

0 62.5 125 250 Meters

OCEAN ECOLOGY

Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

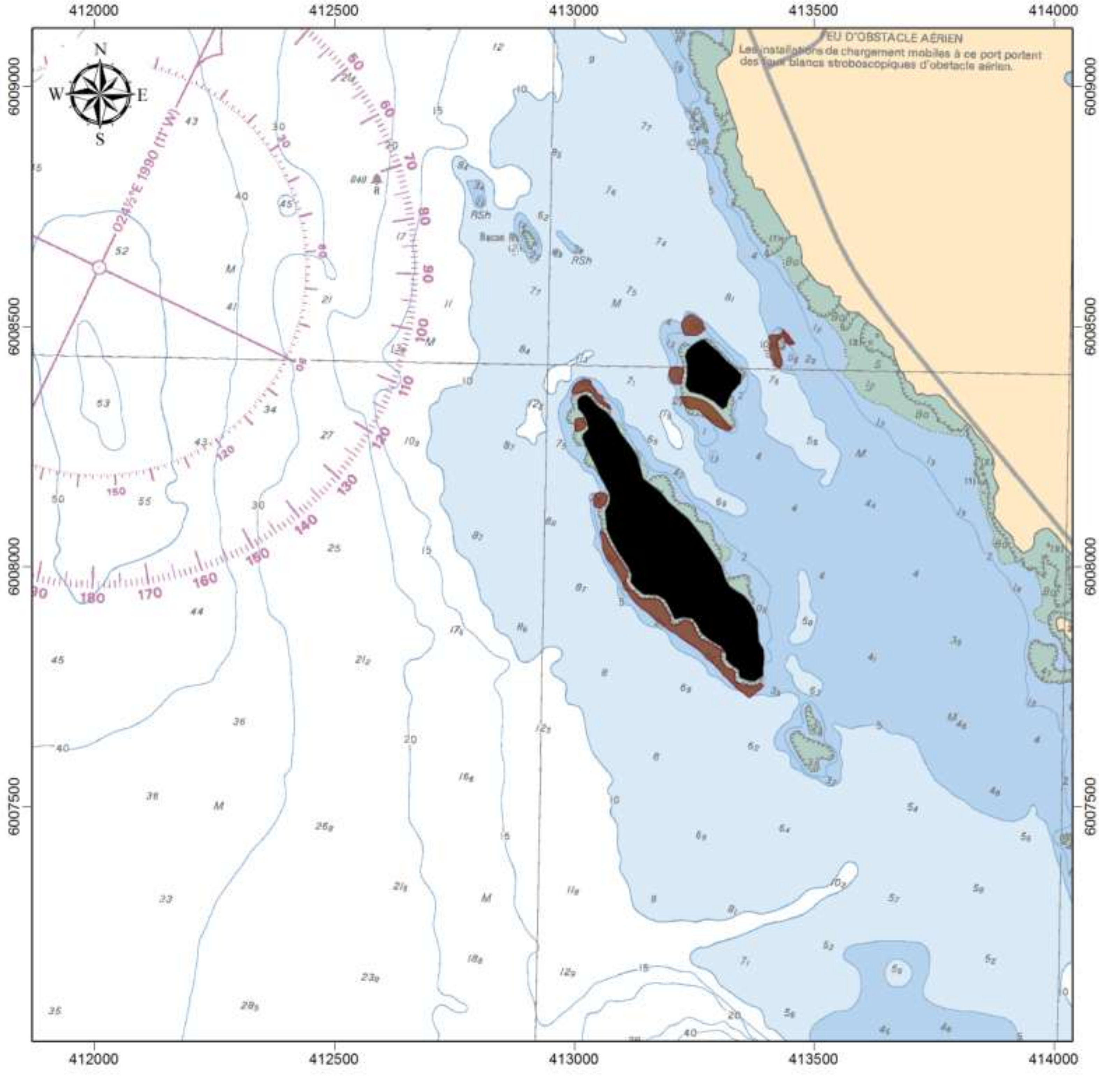


Figure 10.
Map of surface observations of Nereocystis.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

Scale: 1:11,000

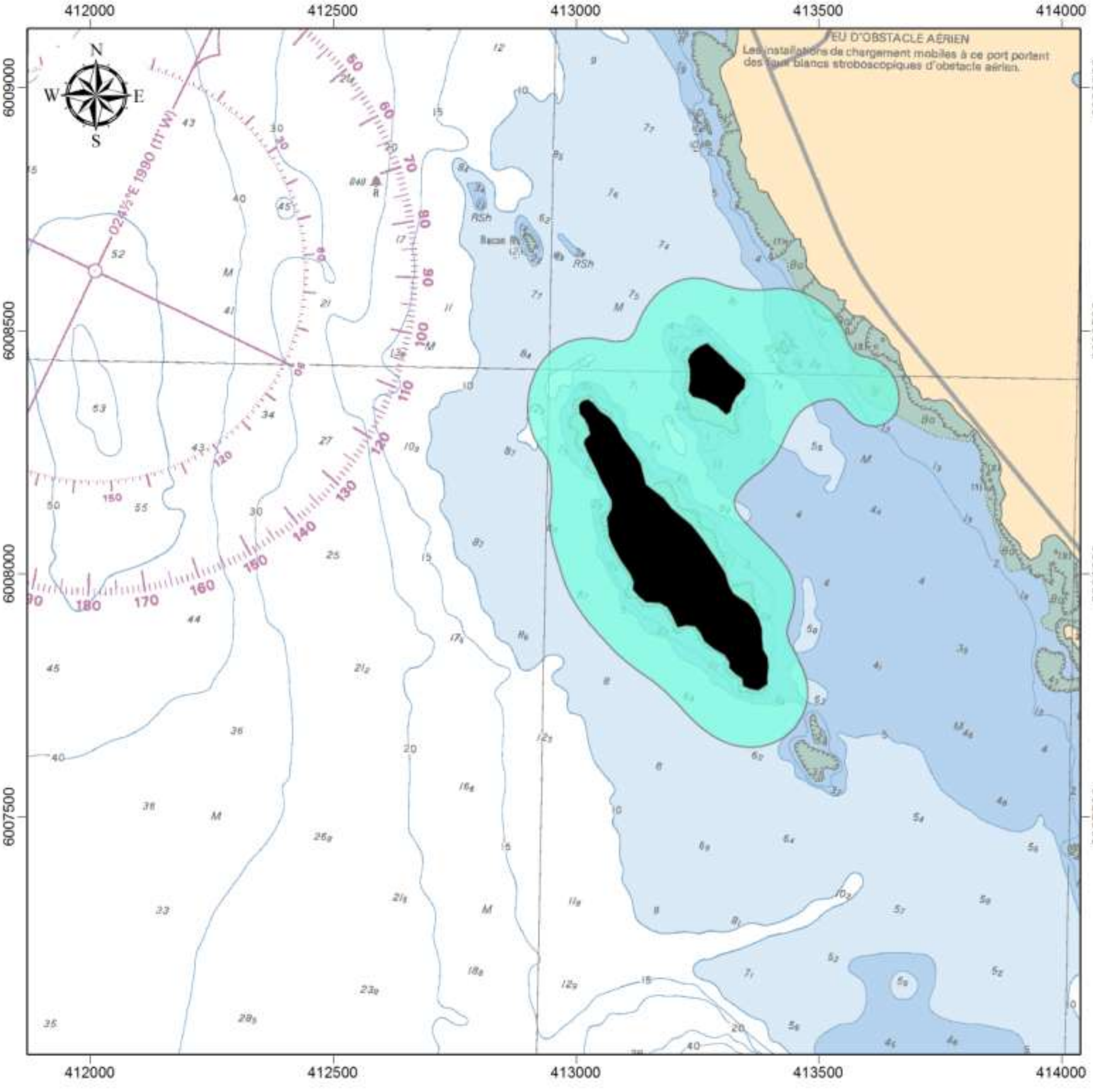
Legend

Rock mask

Nereocystis observations

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 11.
Range map for Nereocystis.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

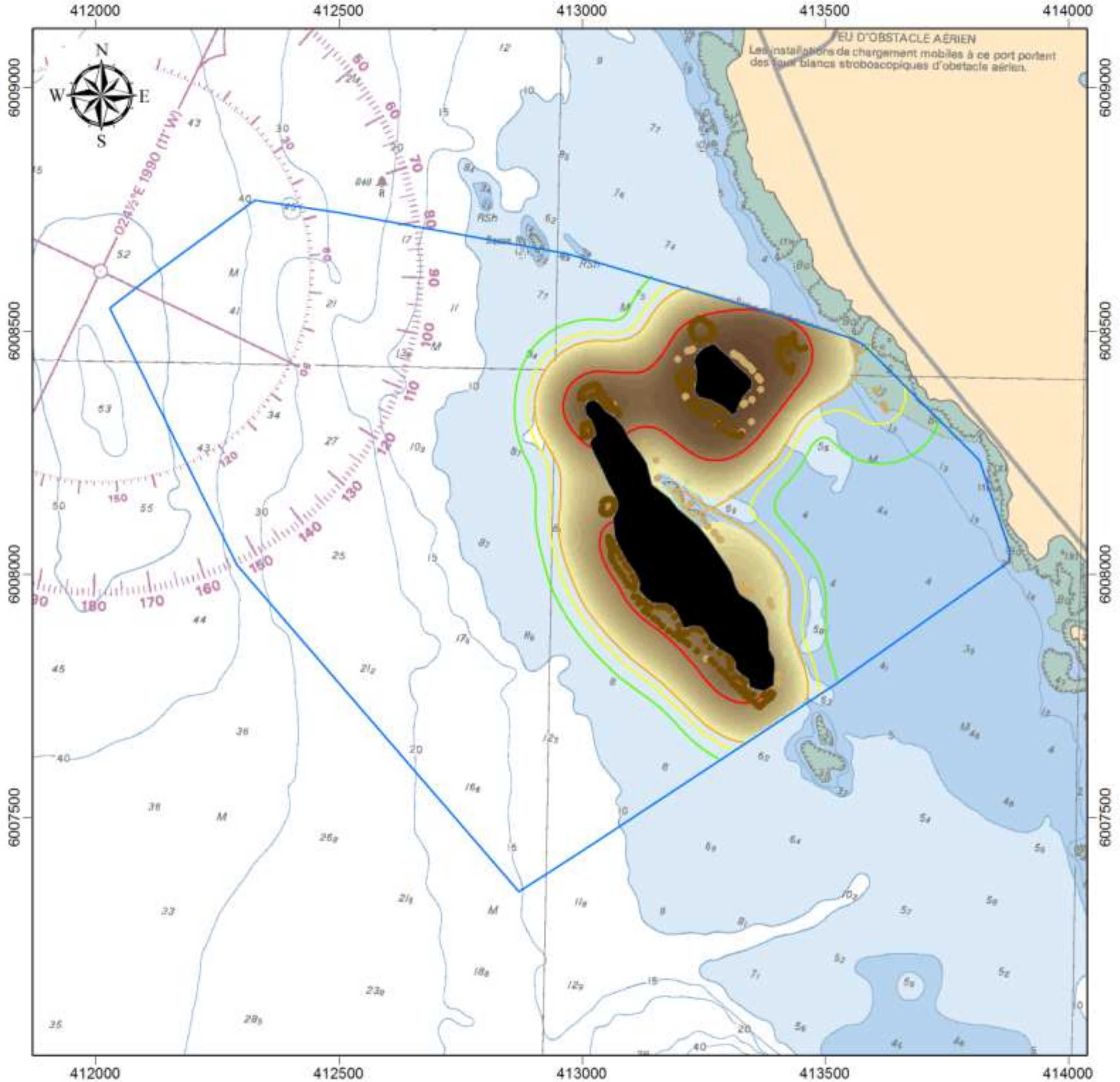
Legend

Rock mask

Nereocystis

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 12.
Density map for Nereocystis.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

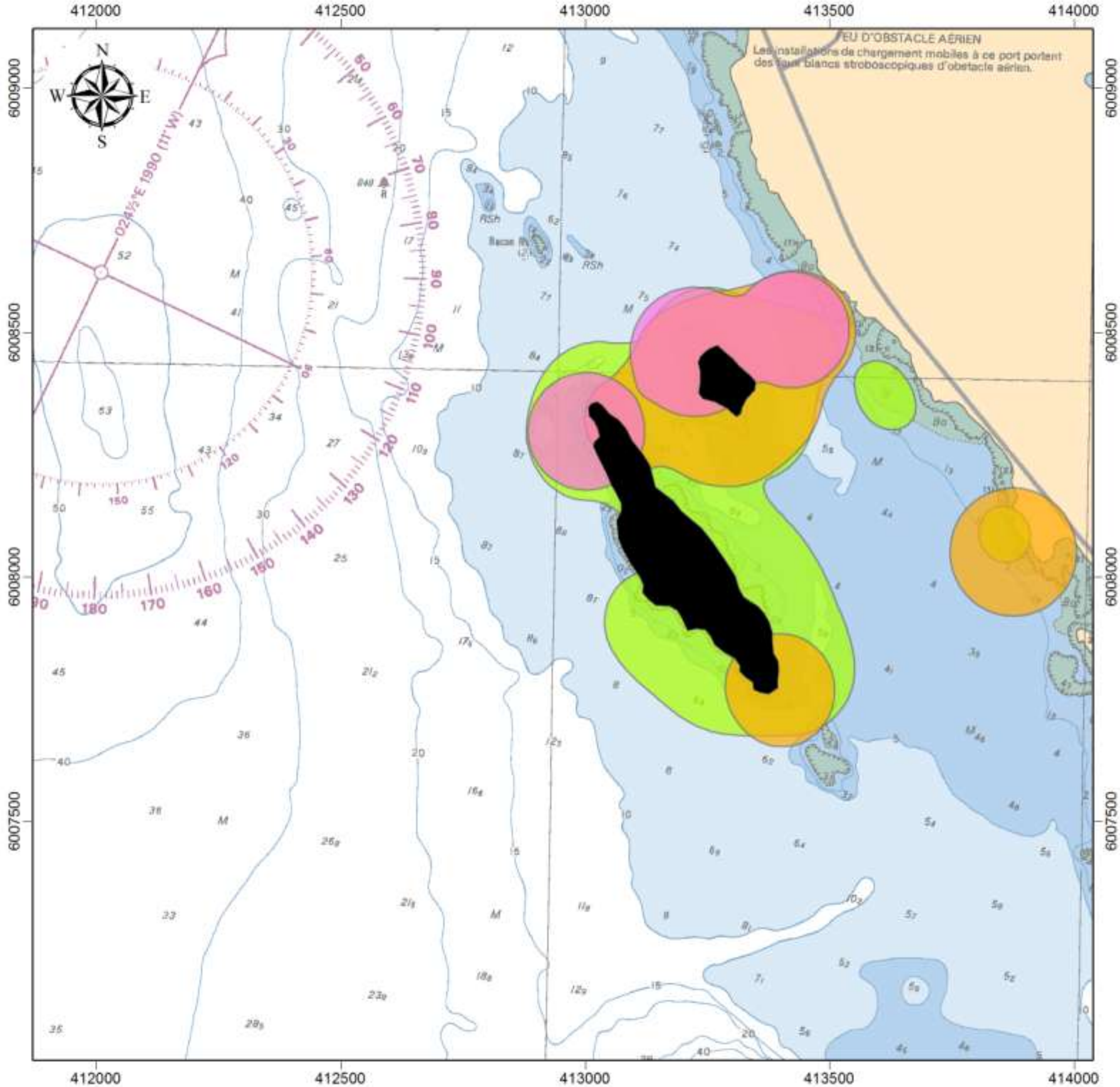
- Video boundary
- Rock mask
- Nereocystis 50% population contour
- Nereocystis 90% population contour
- Nereocystis 95% population contour
- Nereocystis 99% population contour

Nereocystis observations

- Sparse
- Low
- Moderate
- Dense

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 13.
Range map for Laminaria species.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

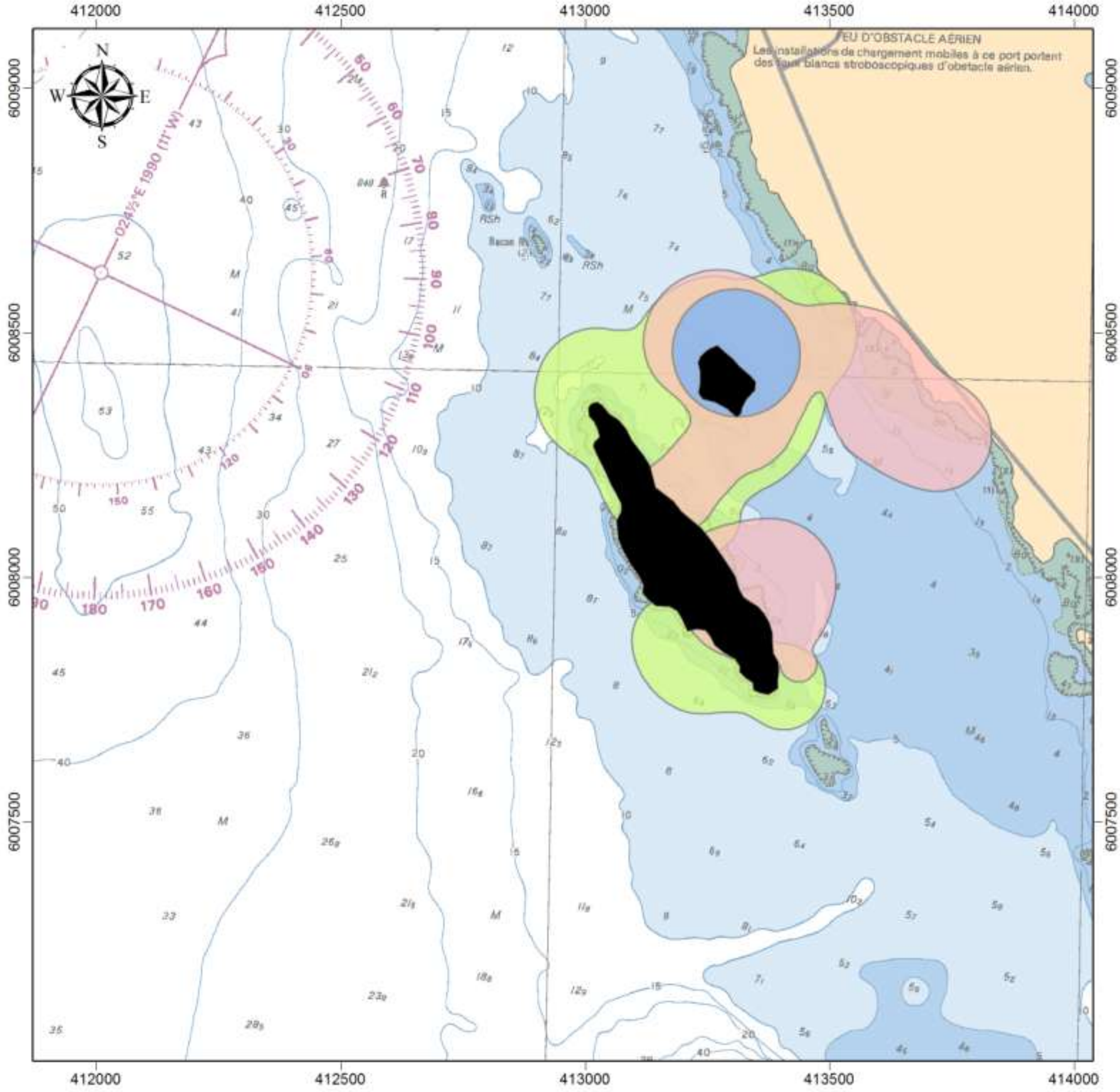
Scale: 1:11,000

Legend

- Rock mask
- Sugar wrack kelp
- Suction-cup kelp
- Split kelp

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 14.
Range map for other kelps.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

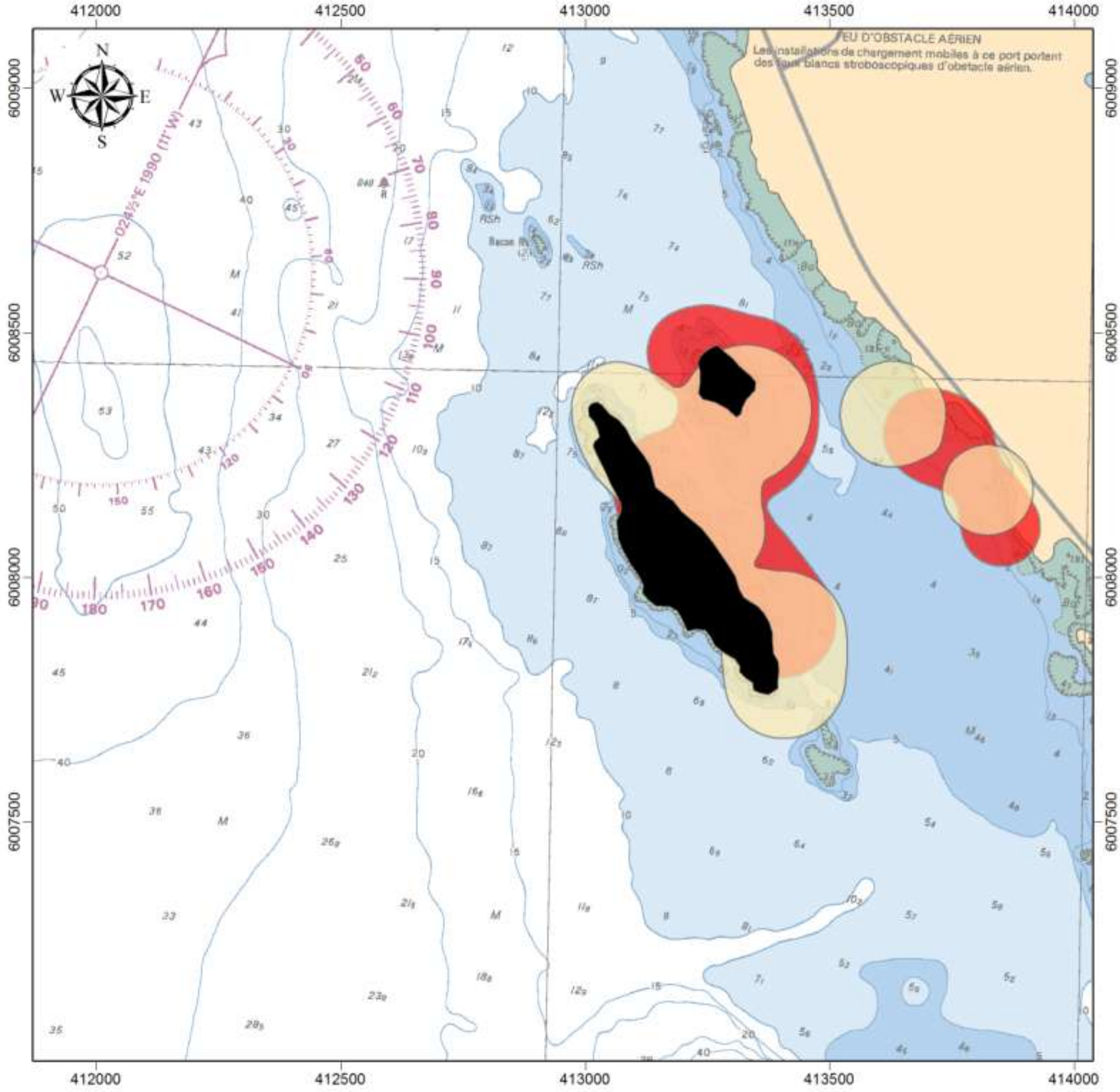
Scale: 1:11,000

Legend

- Rock mask
- Seersucker kelp
- Alaria
- Fringed sea colander kelp

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 15.
Range map for Desmarestia species.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

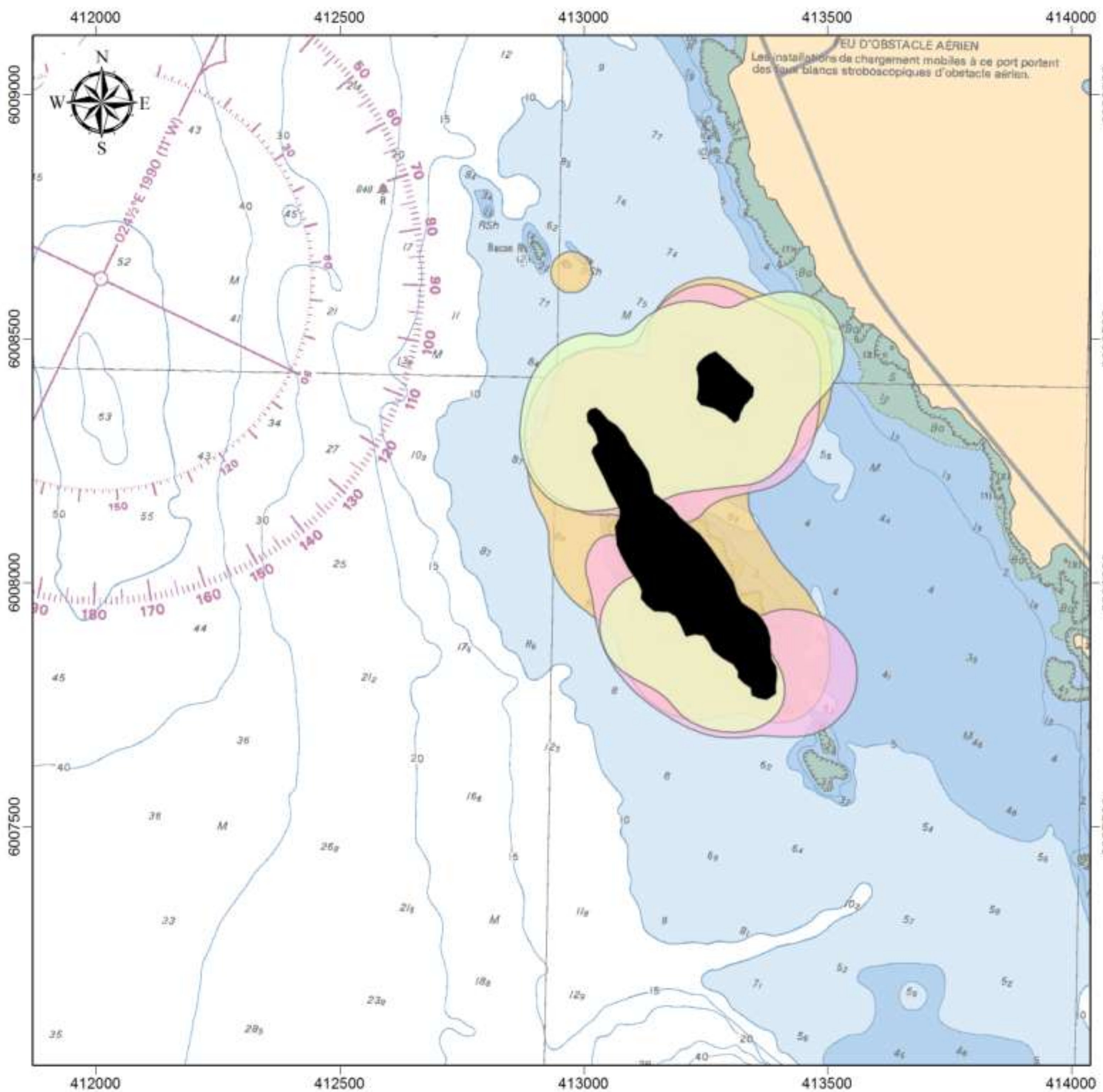
Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 16.
Range map for red seaweeds.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

- Rock mask
- Coralline reds
- Filamentous reds
- Foliose reds

0 62.5 125 250 Meters

OCEAN ECOLOGY

Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

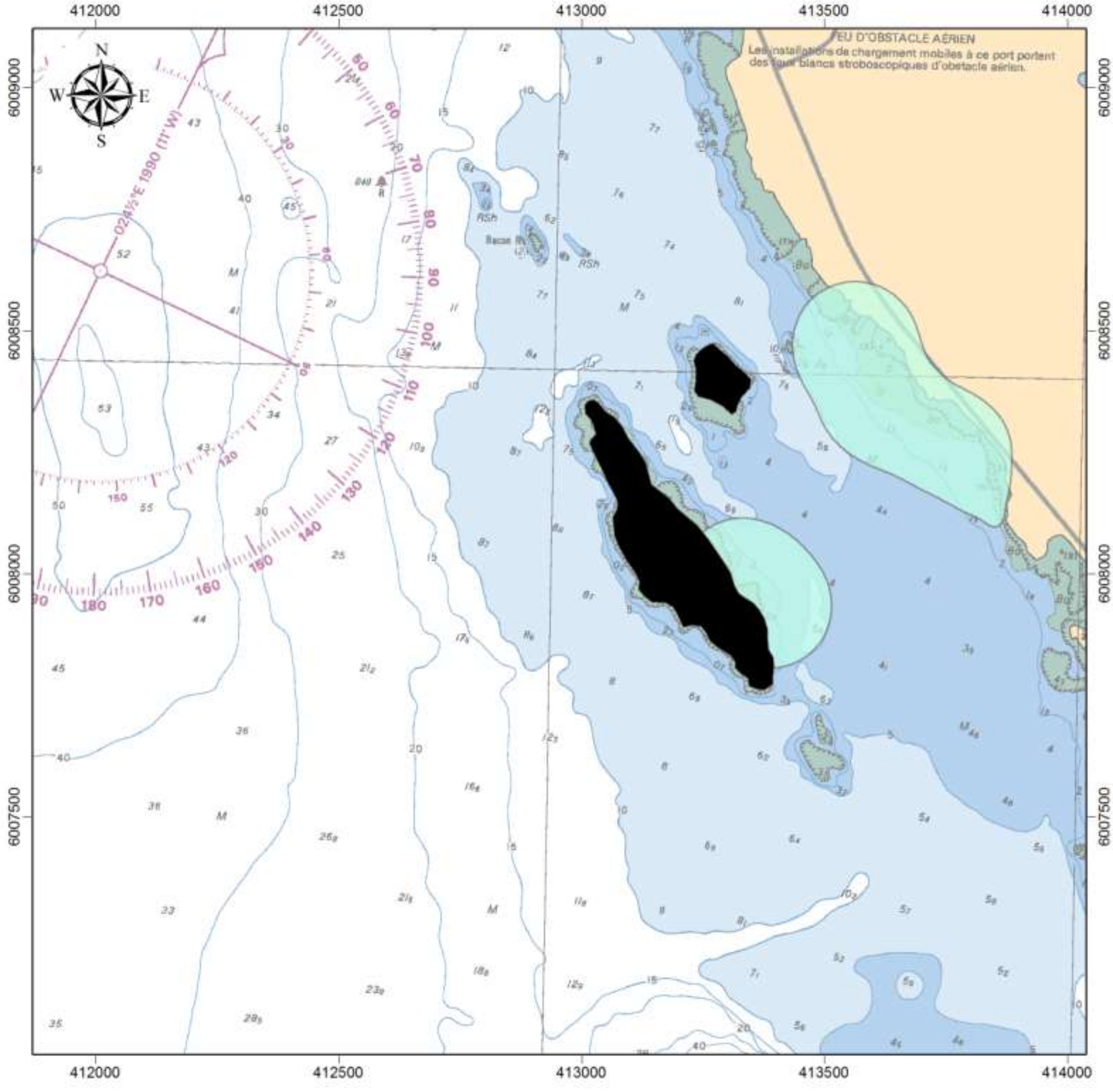


Figure 17.
Range map for eelgrass

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

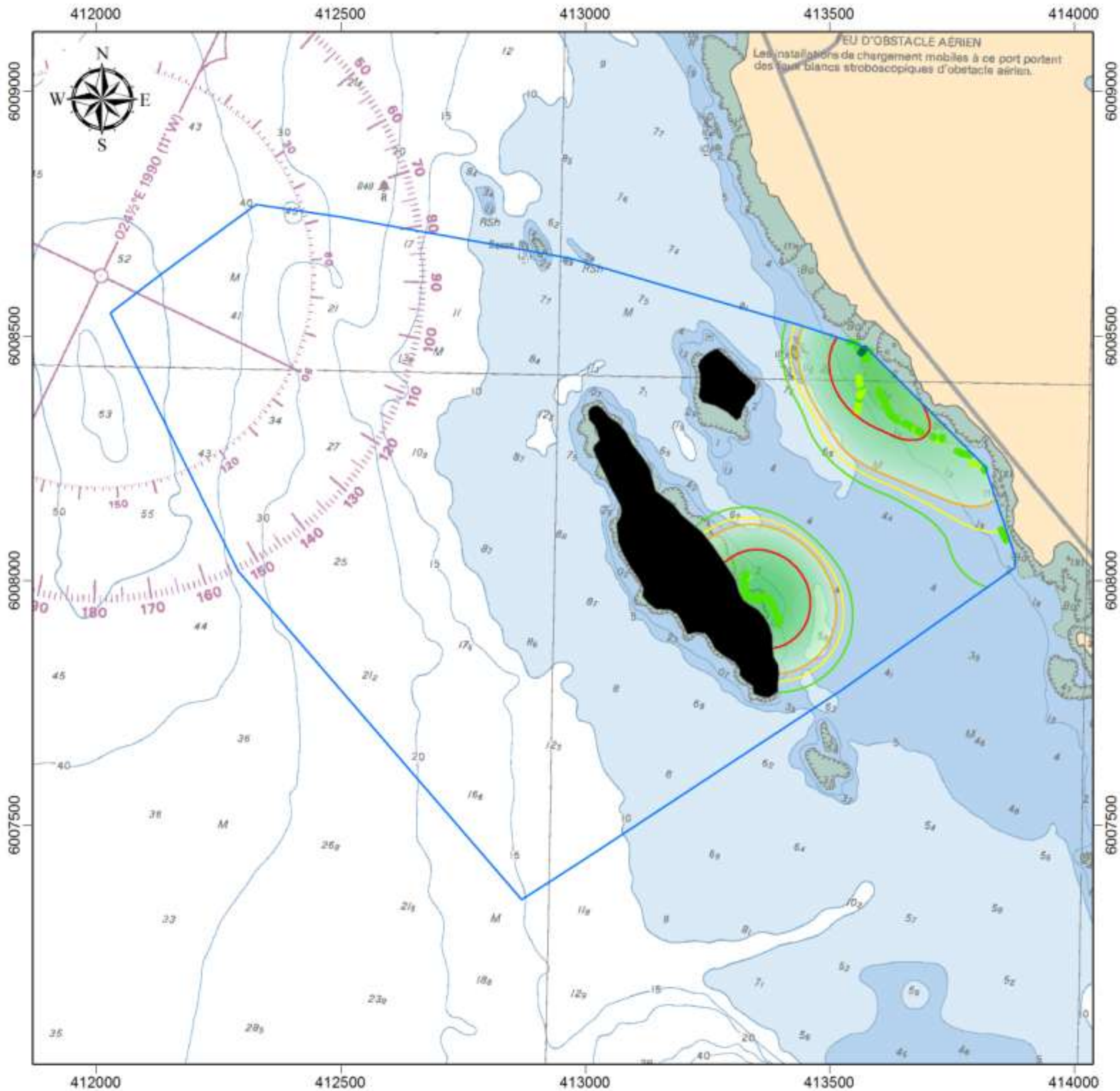
Scale: 1:11,000

Legend

Rock mask
Eelgrass

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 18.
Density map for eelgrass

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

- Video boundary
- Rock mask
- Eelgrass 50% population contour
- Eelgrass 90% population contour
- Eelgrass 95% population contour
- Eelgrass 99% population contour

Eelgrass observations

- Sparse
- Low
- Moderate

0 62.5 125 250 Meters

OCEAN ECOLOGY

Canpotex - Ridley Island
Potash Terminal
Subtidal Video Survey 2

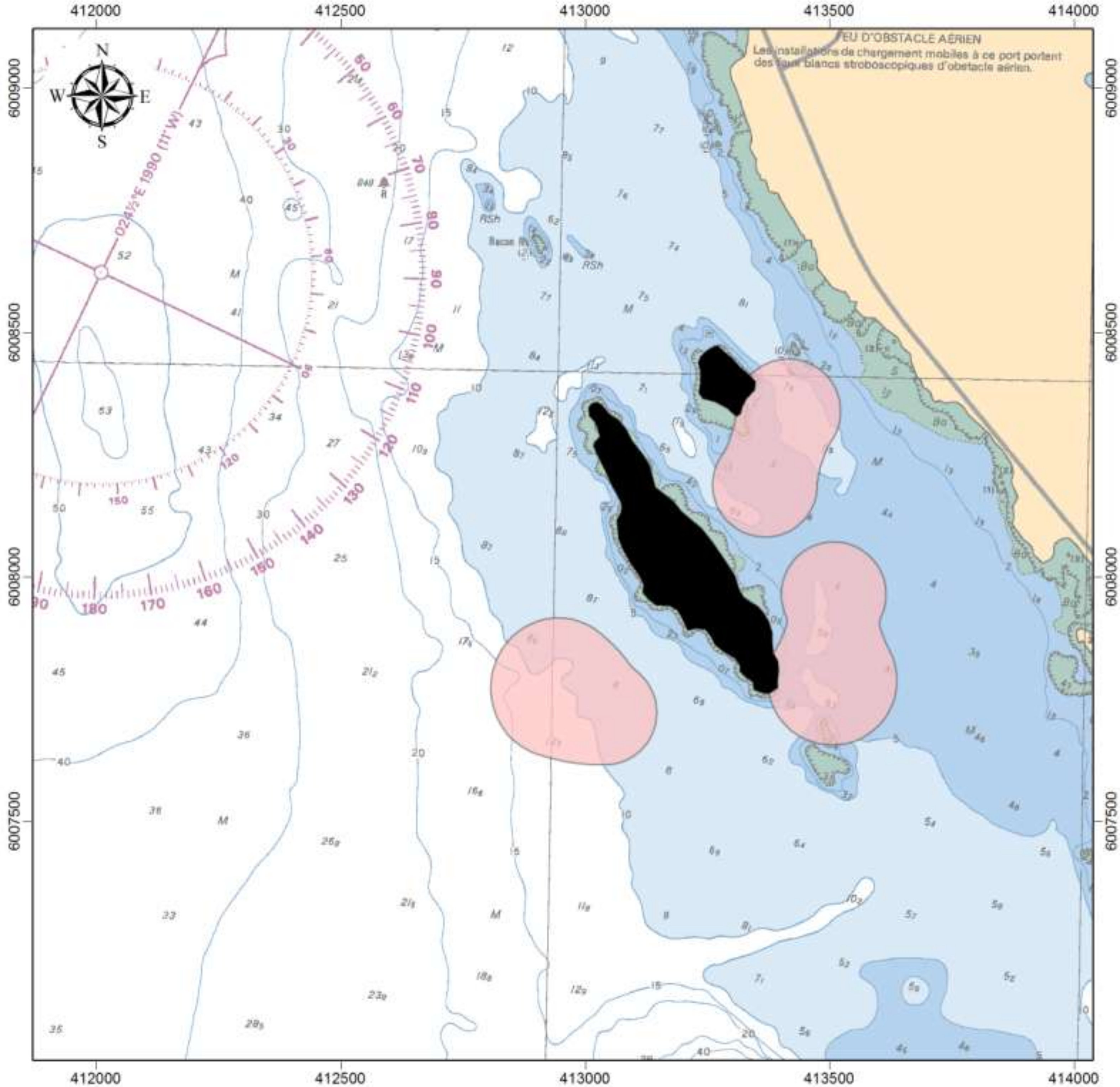


Figure 19.
Range map for bacterial mats.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

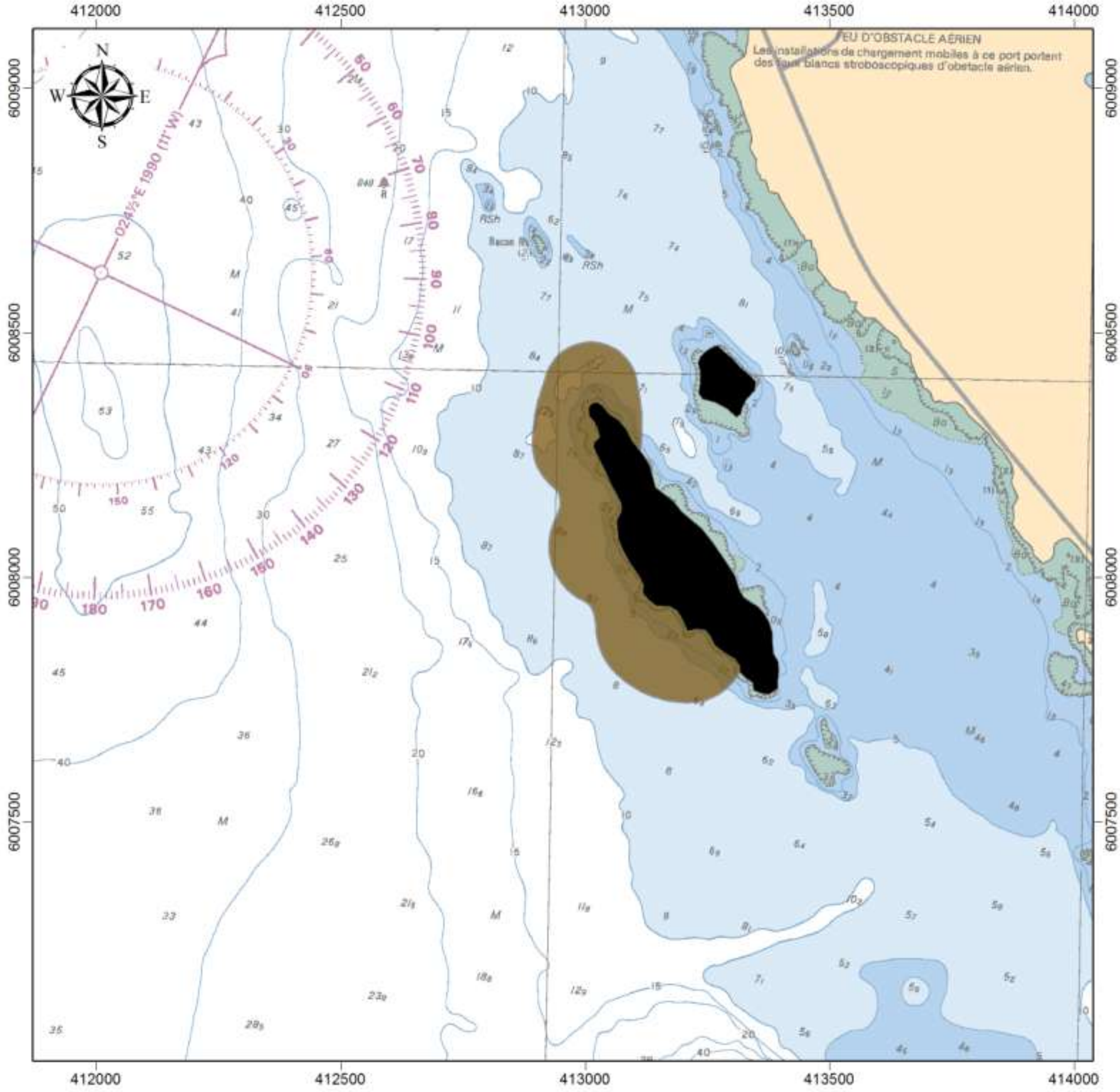
Scale: 1:11,000

Legend

- Rock mask
- Bacterial mat

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 20.
Range map for sponges.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

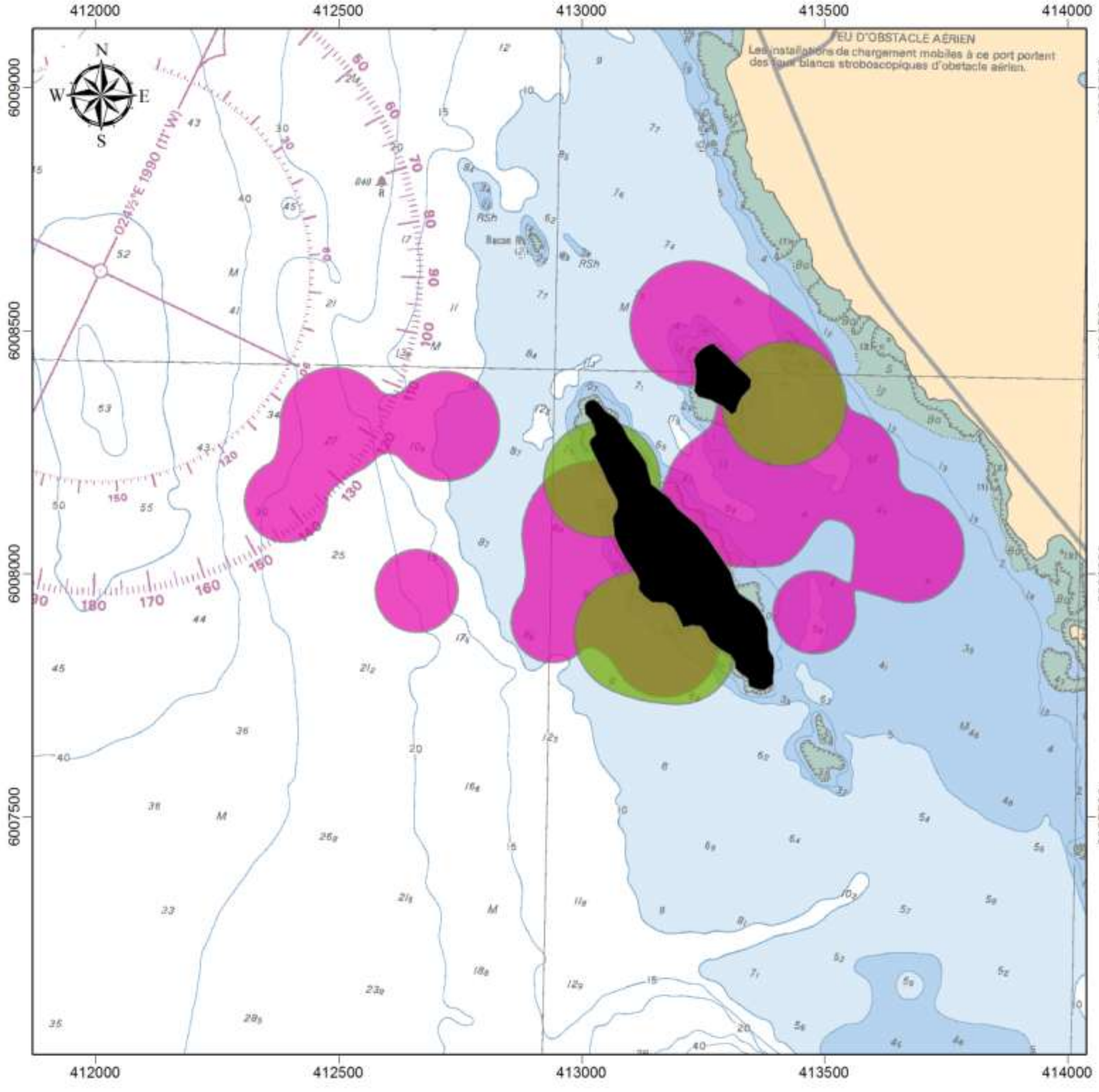
Scale: 1:11,000

Legend

- Rock mask
- Stalked vase sponge

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 21.
Range map for anemones.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

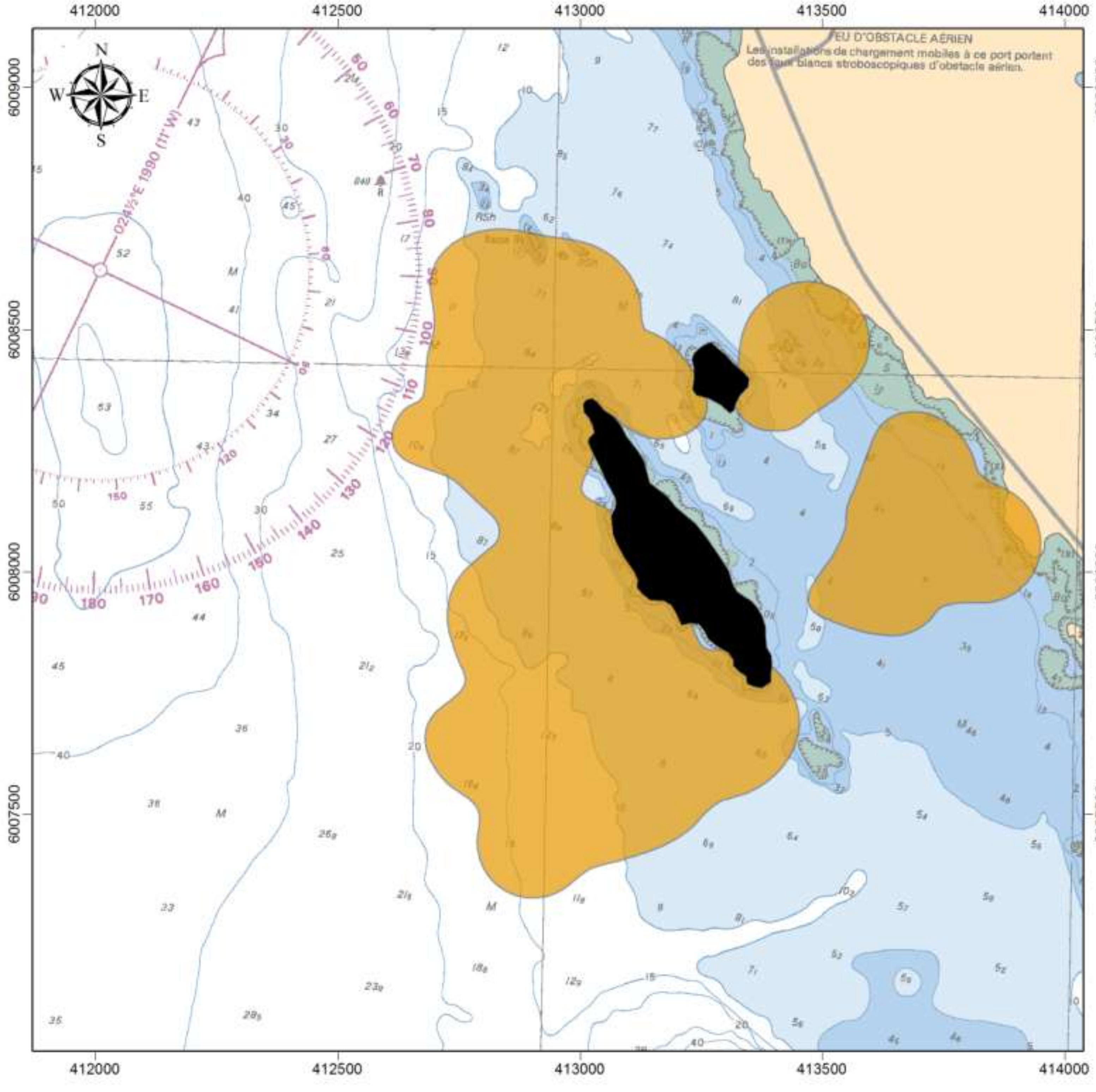
Scale: 1:11,000

Legend

- Rock mask
- Snake lock anemone
- Plumose anemone

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 22.
Range map for orange sea pens.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

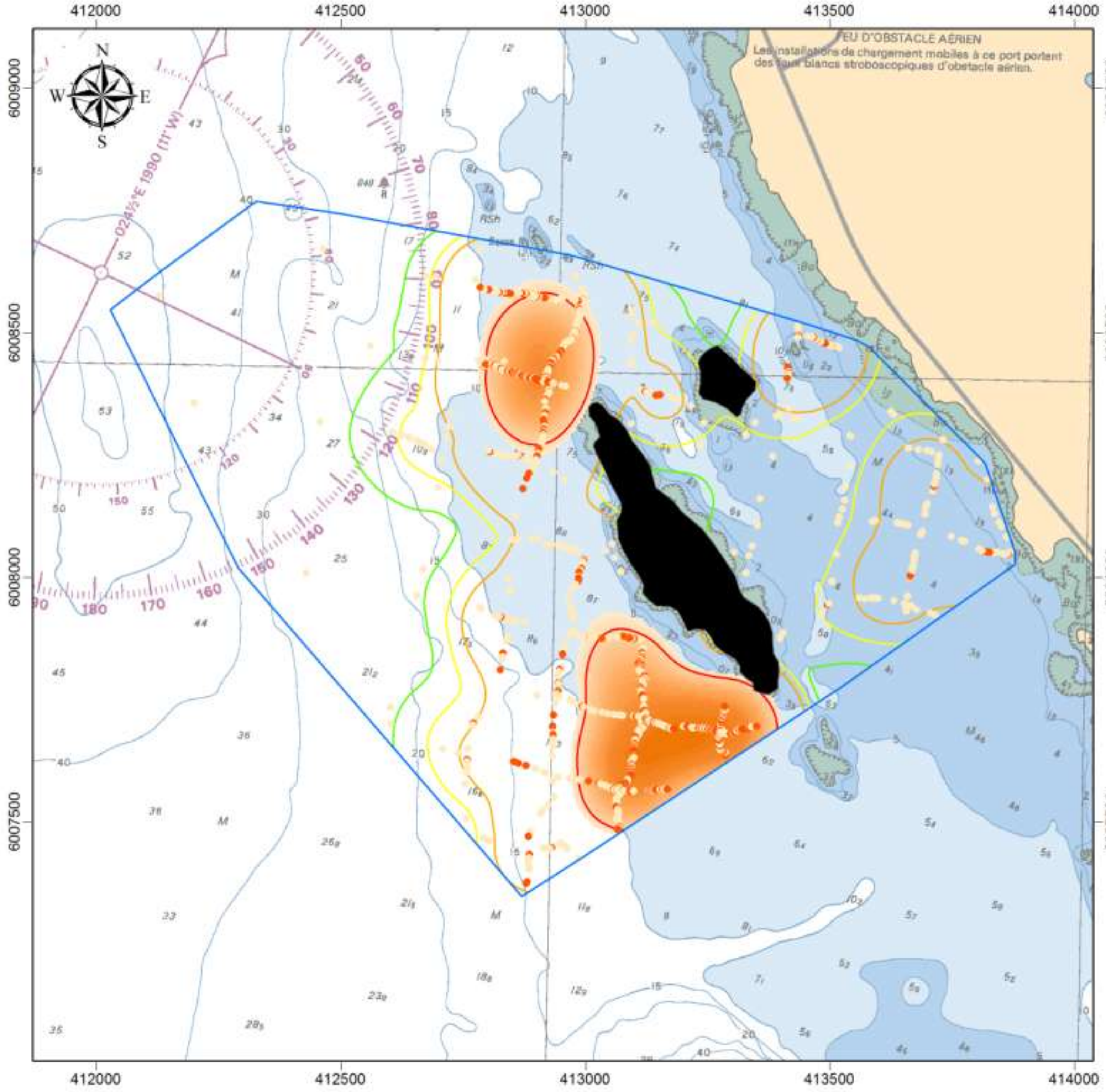
Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

Scale: 1:11,000

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 23.
Density map for orange sea pens.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

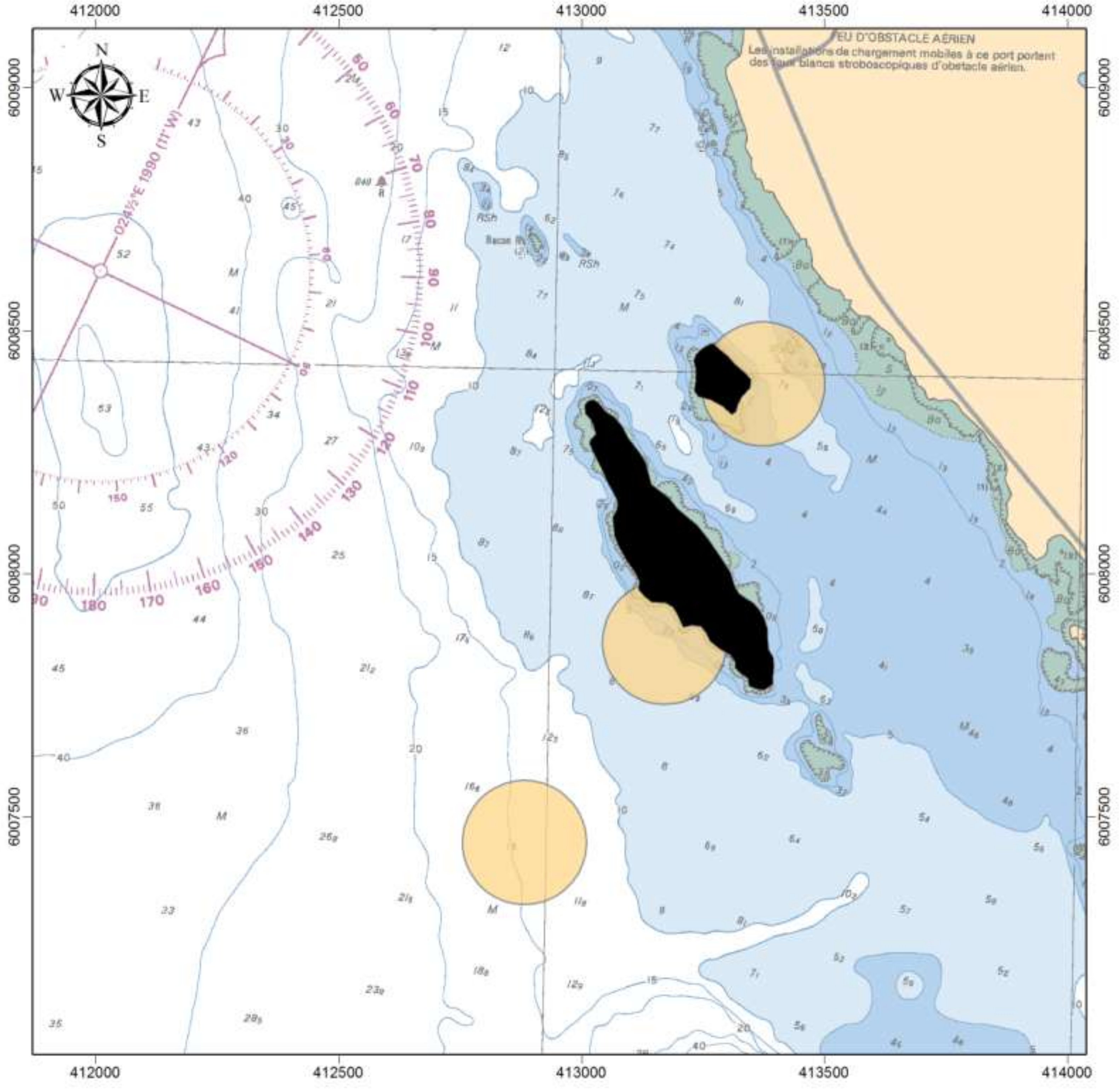
- Video boundary
- Rock mask
- Orange sea pens 50% population contour
- Orange sea pens 90% population contour
- Orange sea pens 95% population contour
- Orange sea pens 99% population contour

Orange sea pens observations

- Few
- Patchy

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 24.
Range map for gastropods.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

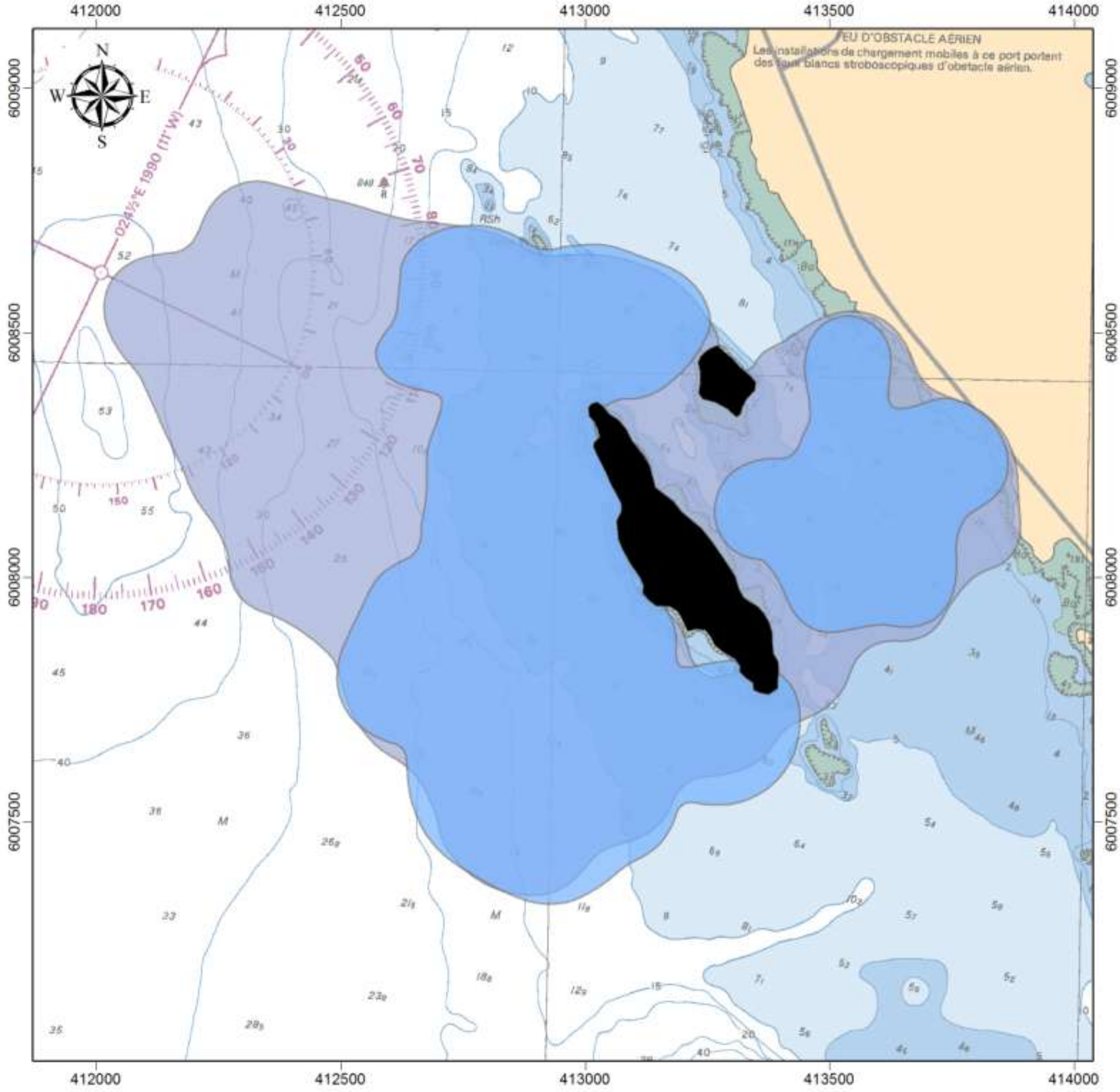
Legend

Rock mask

Dogwinkle

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 25.
Range map for clams and unmounded holes.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

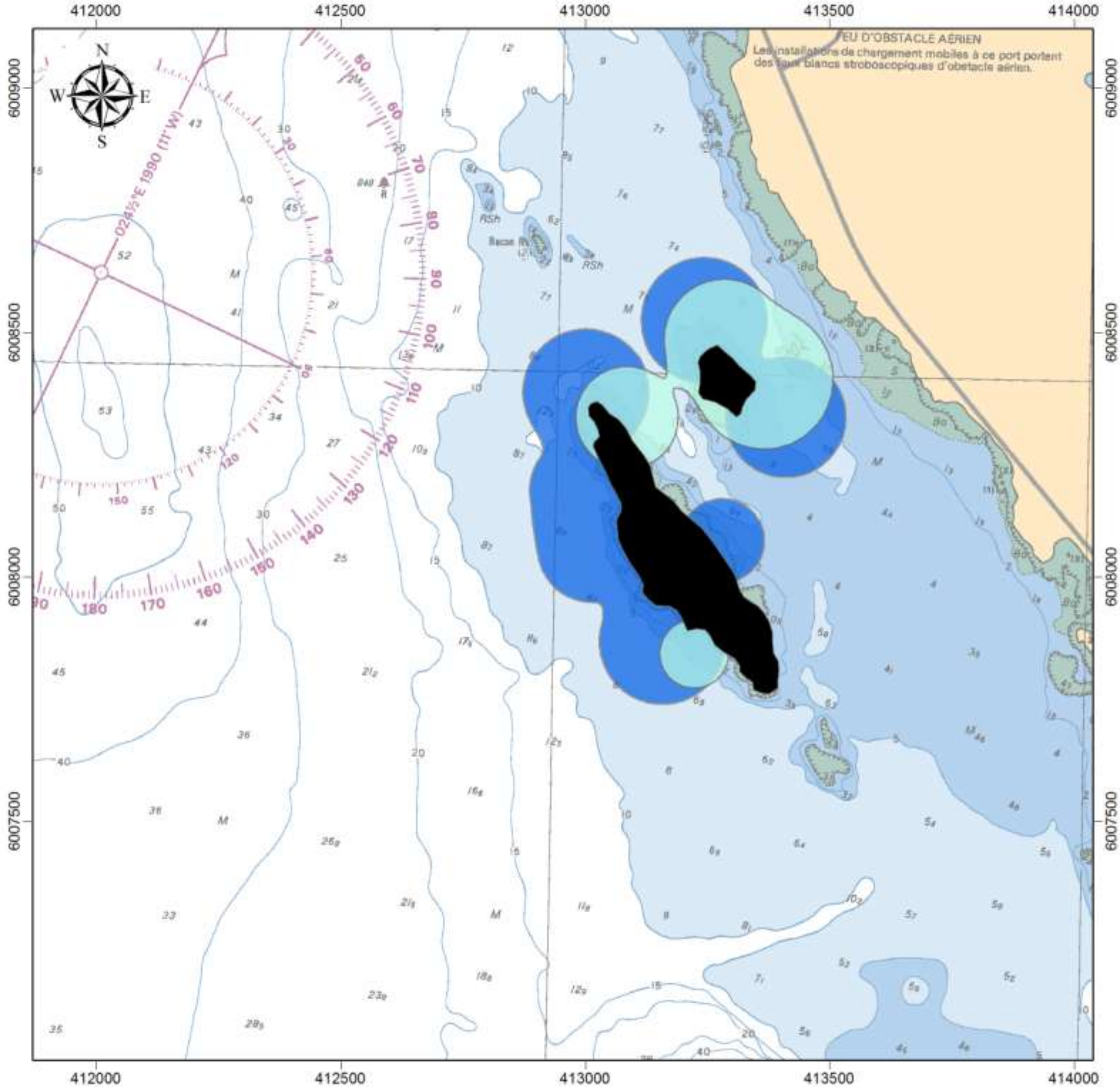
Scale: 1:11,000

Legend

- Rock mask
- Geoduck clam
- Unmounded hole

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 26.
Range map for polychaetes.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

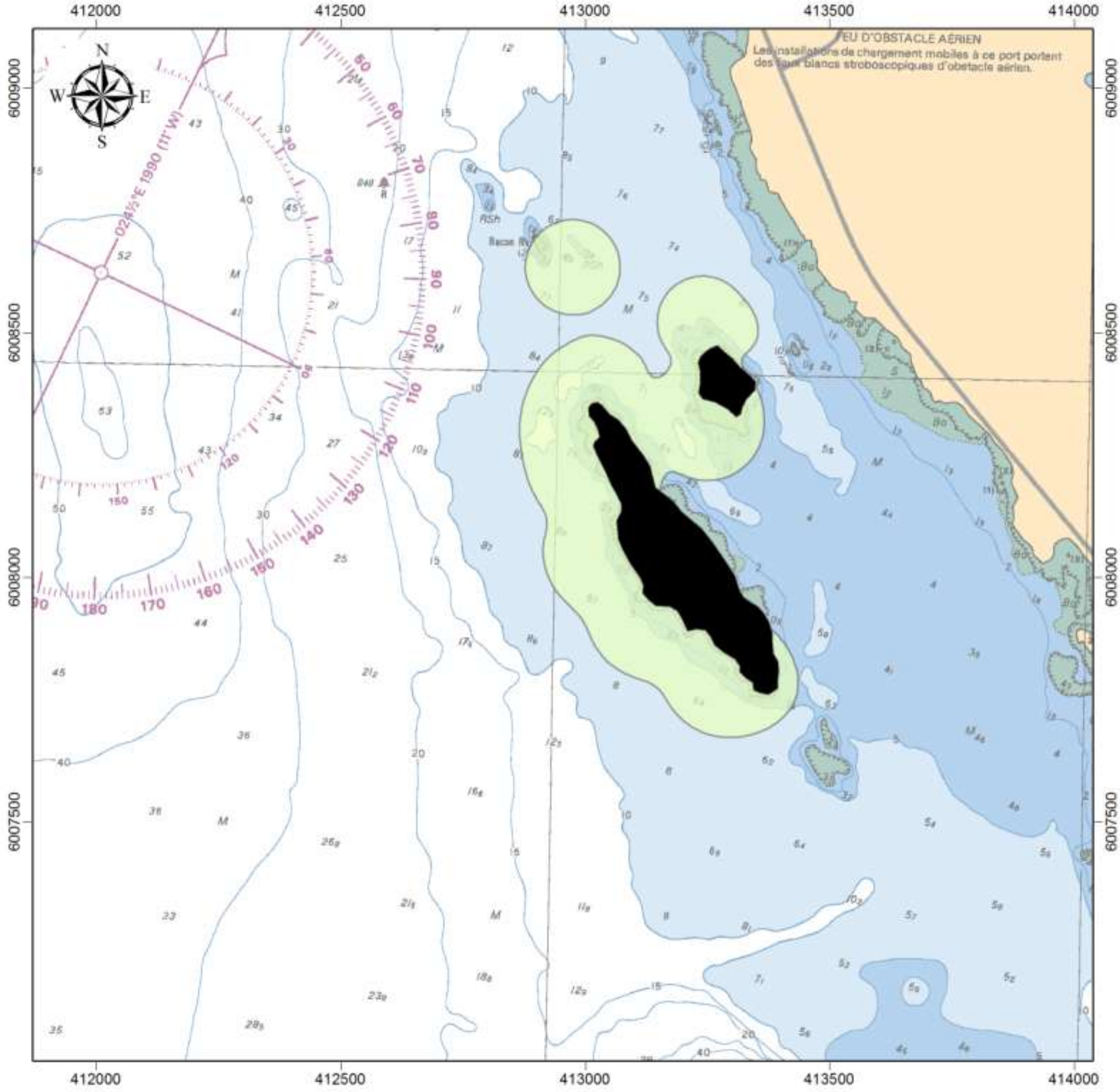
Rock mask

Calcareous tube worm

Parchment tube worm

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 27.
Range map for the "bryozoan complex".

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

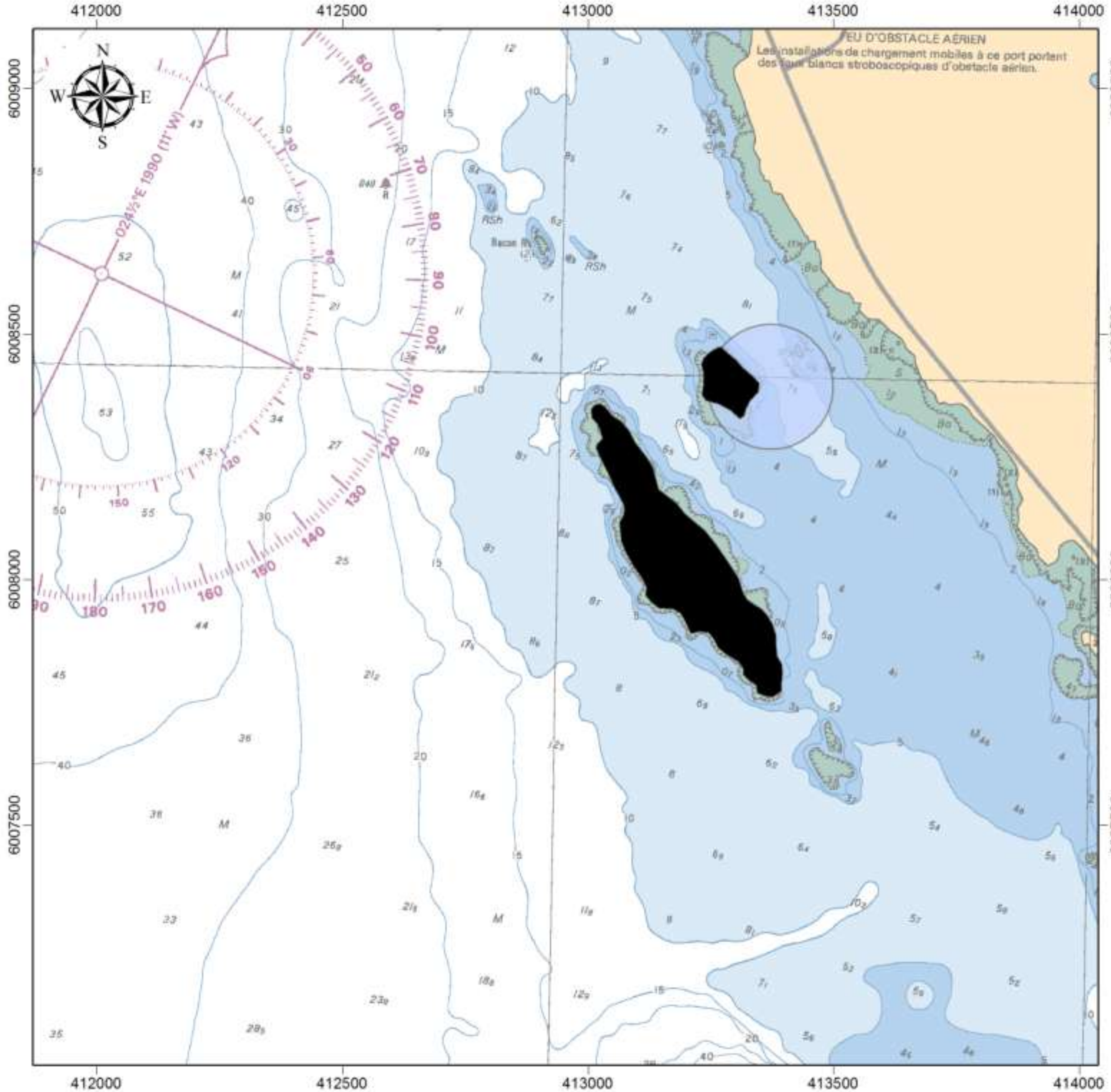
Legend

Rock mask

Bryozoan complex

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 28.
Range map for brachiopods.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

Scale: 1:11,000

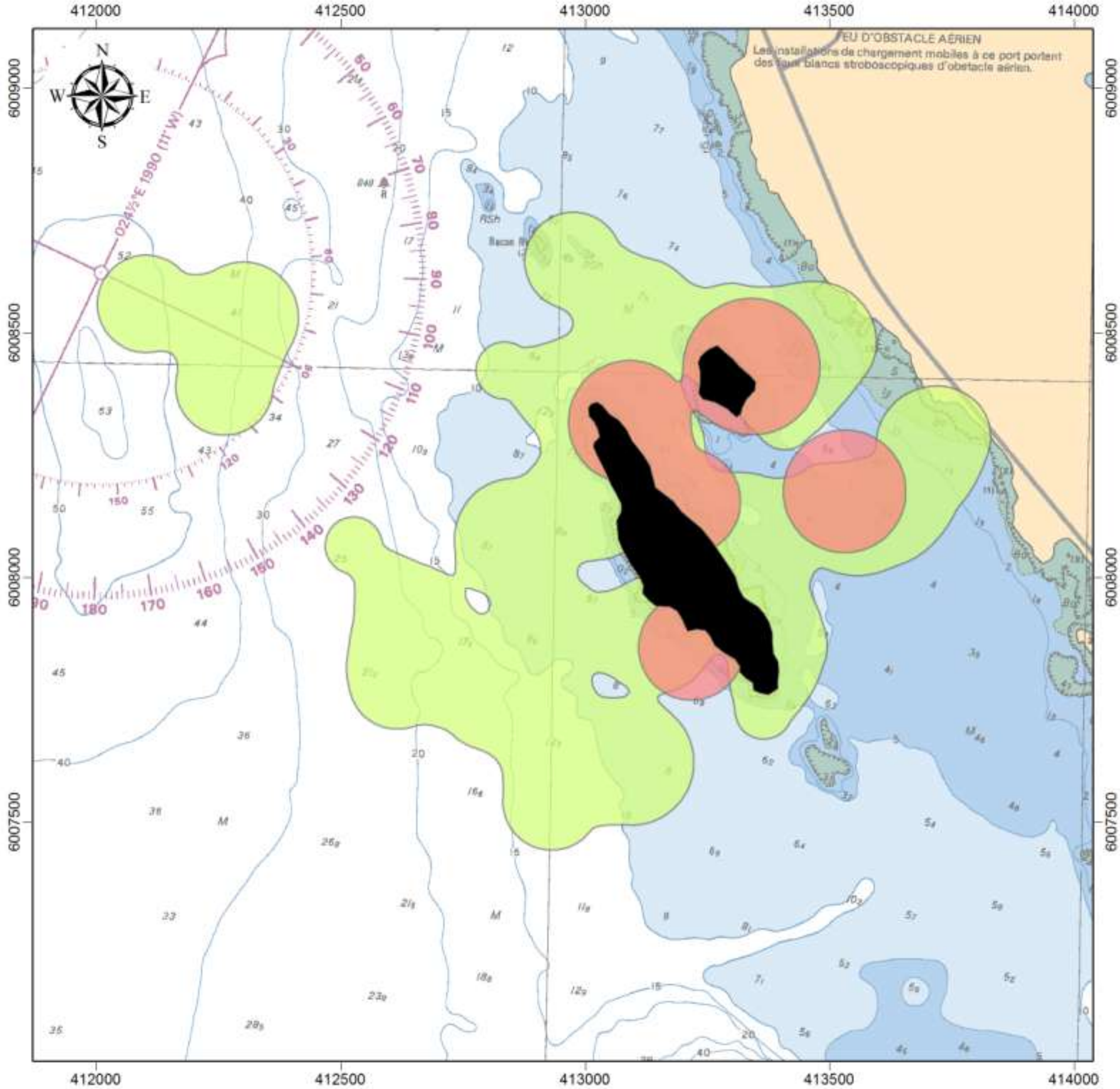
Legend

Rock mask

California lamp shell

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 29.
Range map for crabs.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

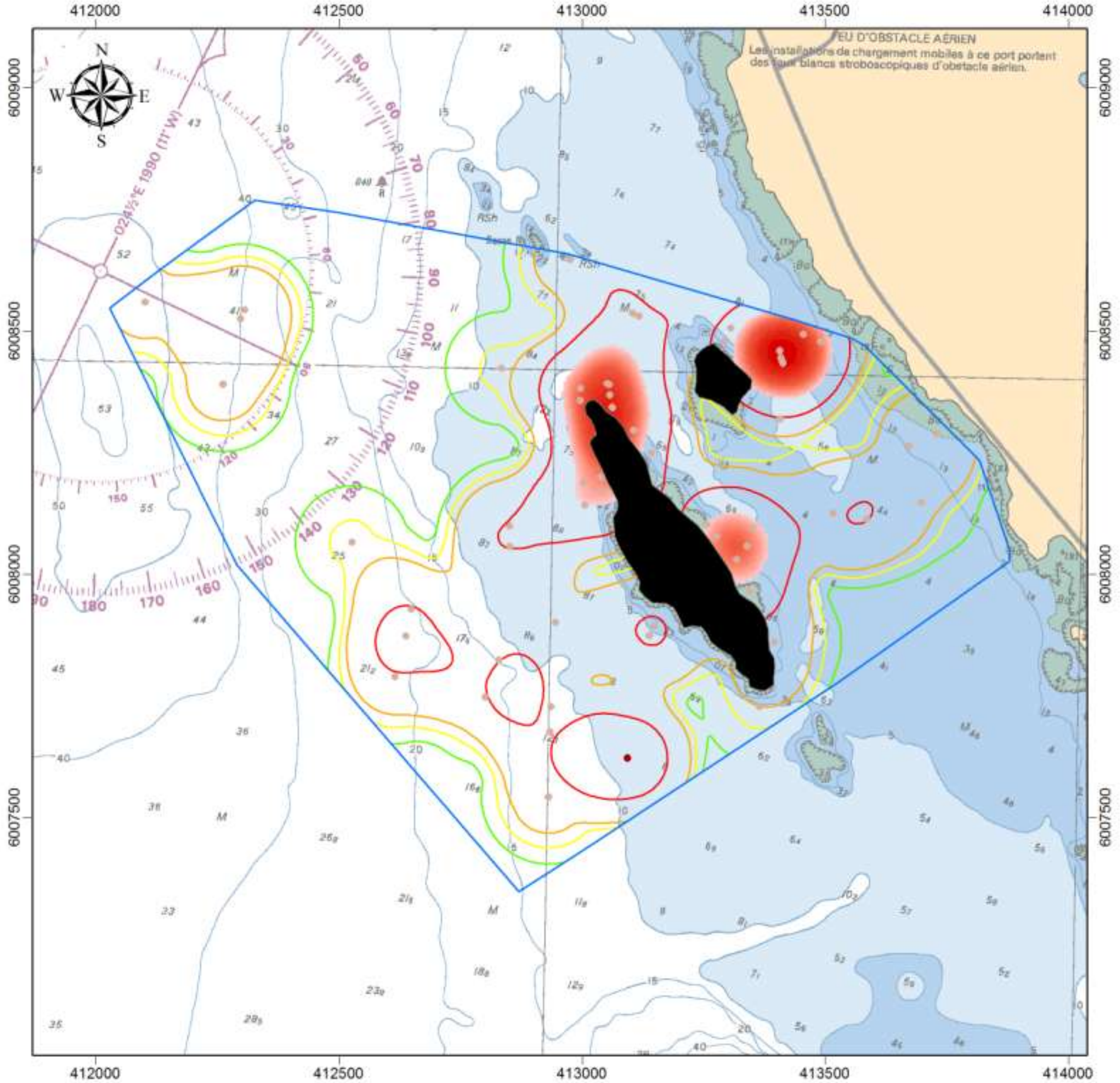
Scale: 1:11,000

Legend

- Rock mask
- Decorator crab
- Dungeness crab

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 30.
Density map for Dungeness crabs.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

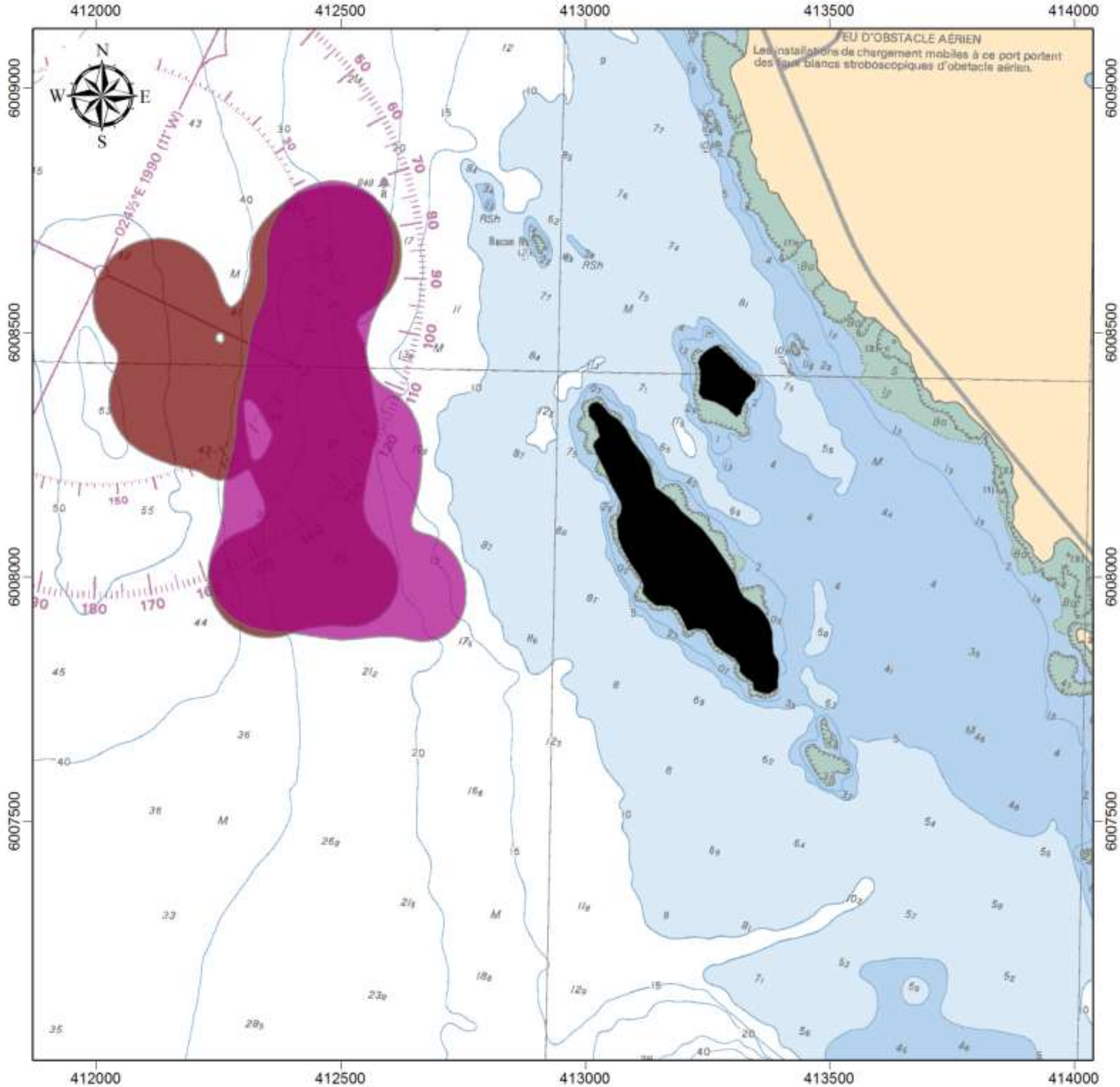
- Video boundary
- Rock mask
- Dungeness crabs 50% population contour
- Dungeness crabs 90% population contour
- Dungeness crabs 95% population contour
- Dungeness crabs 99% population contour

Dungeness crabs observations

- Few
- Patchy

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 31.
Range map for pandalids.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

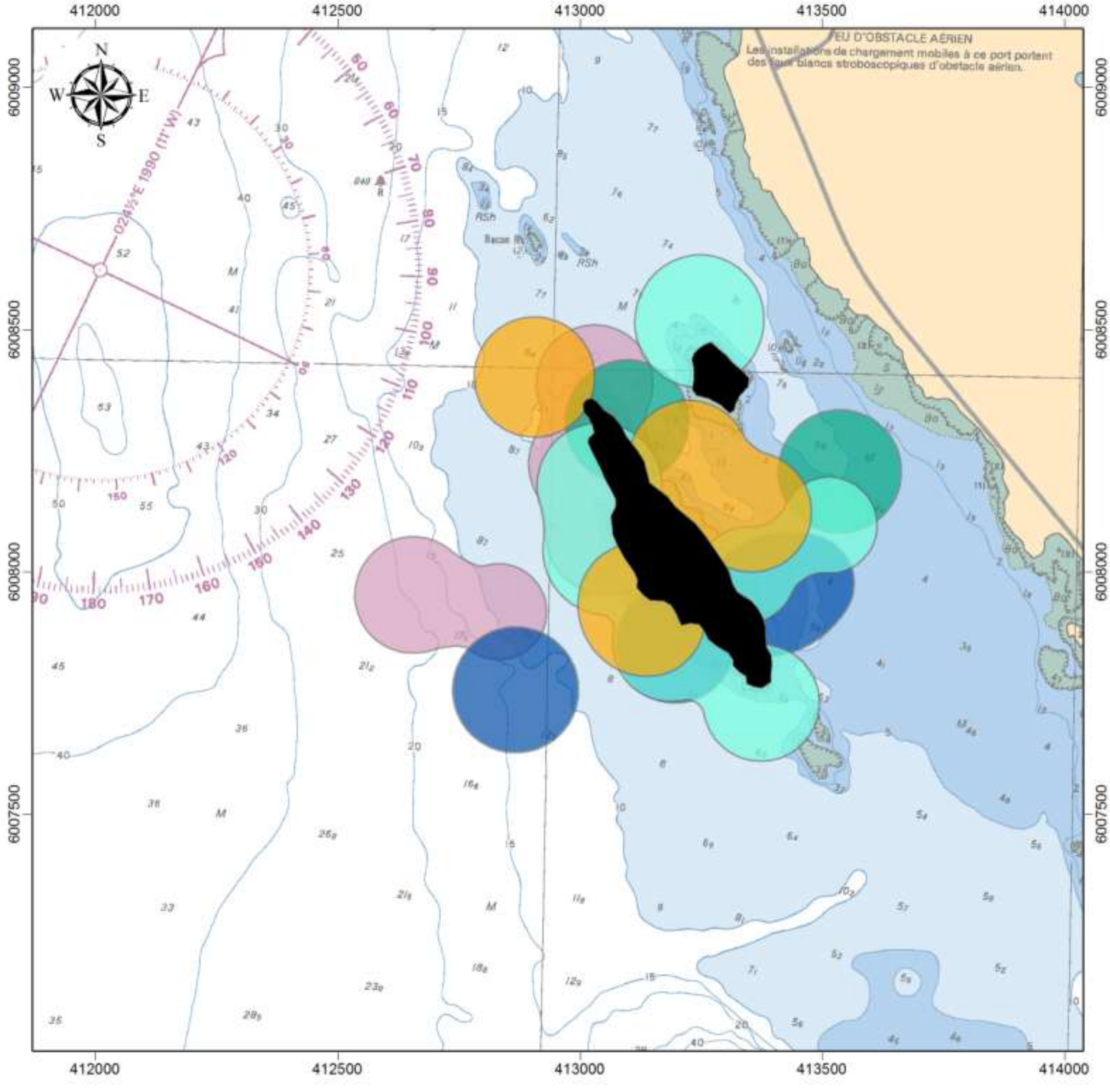
Scale: 1:11,000

Legend

Rock mask
Spiny pink shrimp
Spot prawn

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 32.
Range map 1 for seastars.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

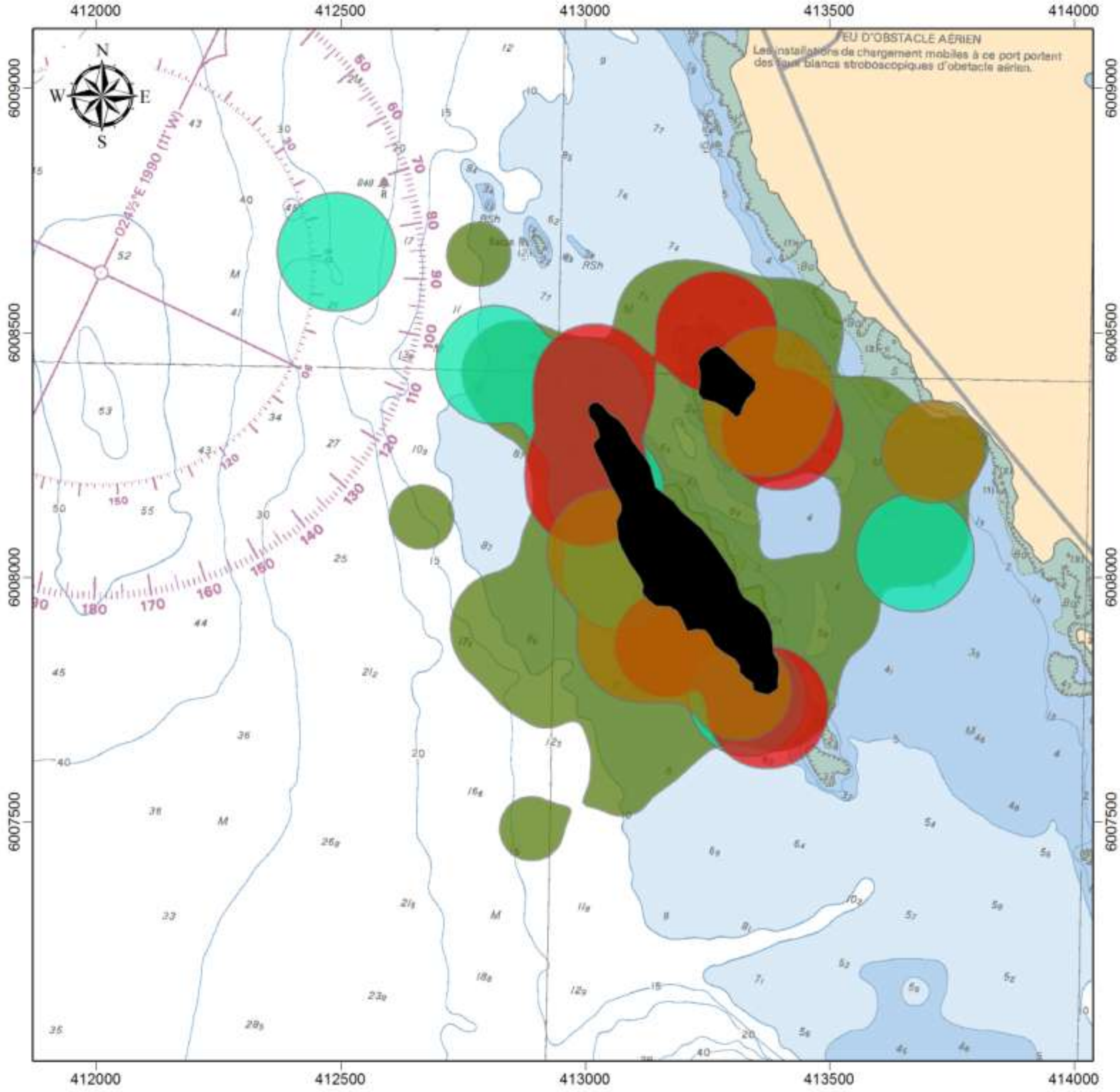
Scale: 1:11,000

Legend

- Rock mask
- Long ray star
- False ochre seastar
- Solaster sp.
- Spiny mudstar
- Vermilion star

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 33.
Range map 2 for seastars.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

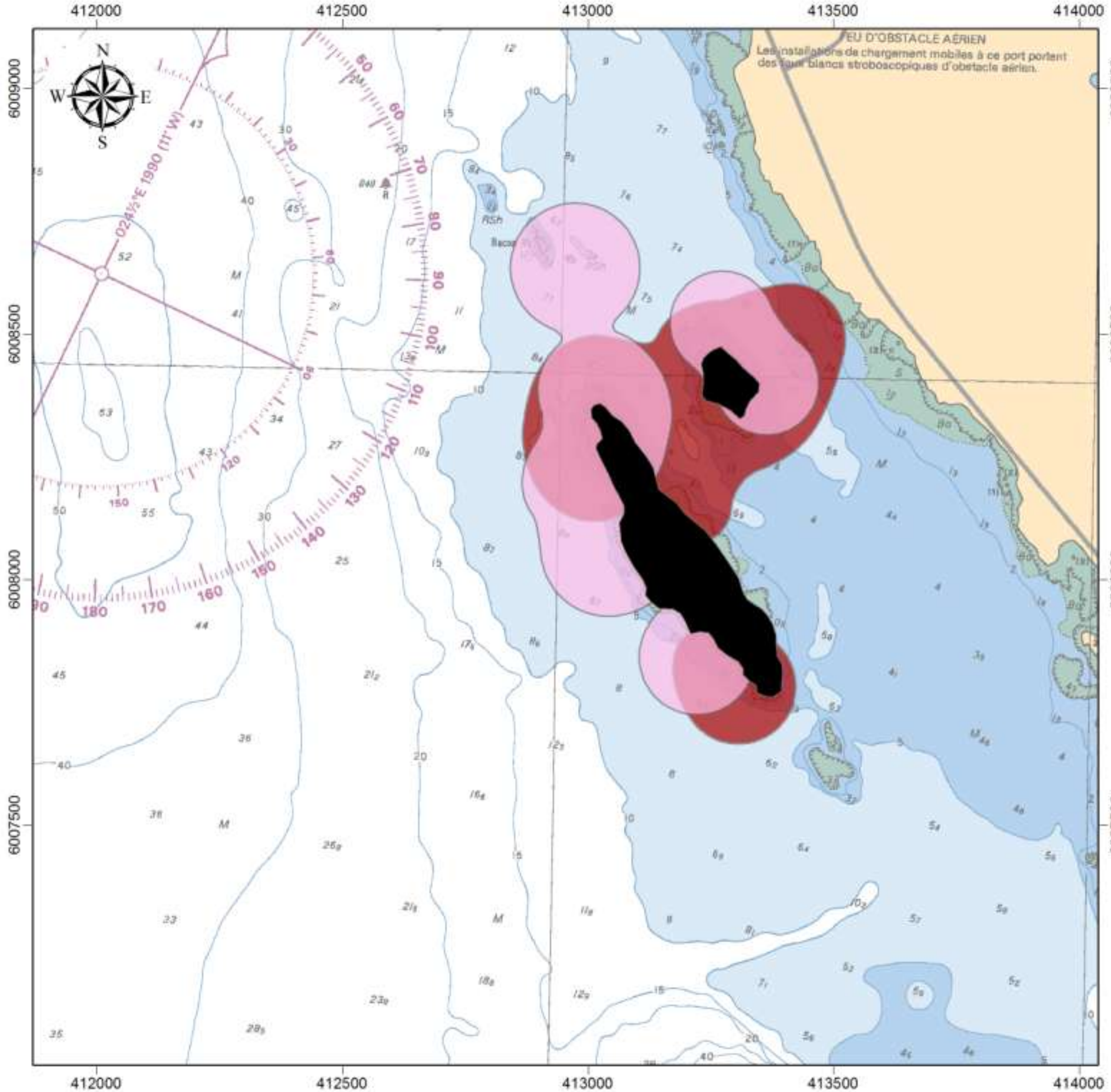
Scale: 1:11,000

Legend

- Rock mask
- Short-spined seastar
- Ochre seastar
- Painted star
- Sunflower seastar

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 34.
Range map for sea cucumbers.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

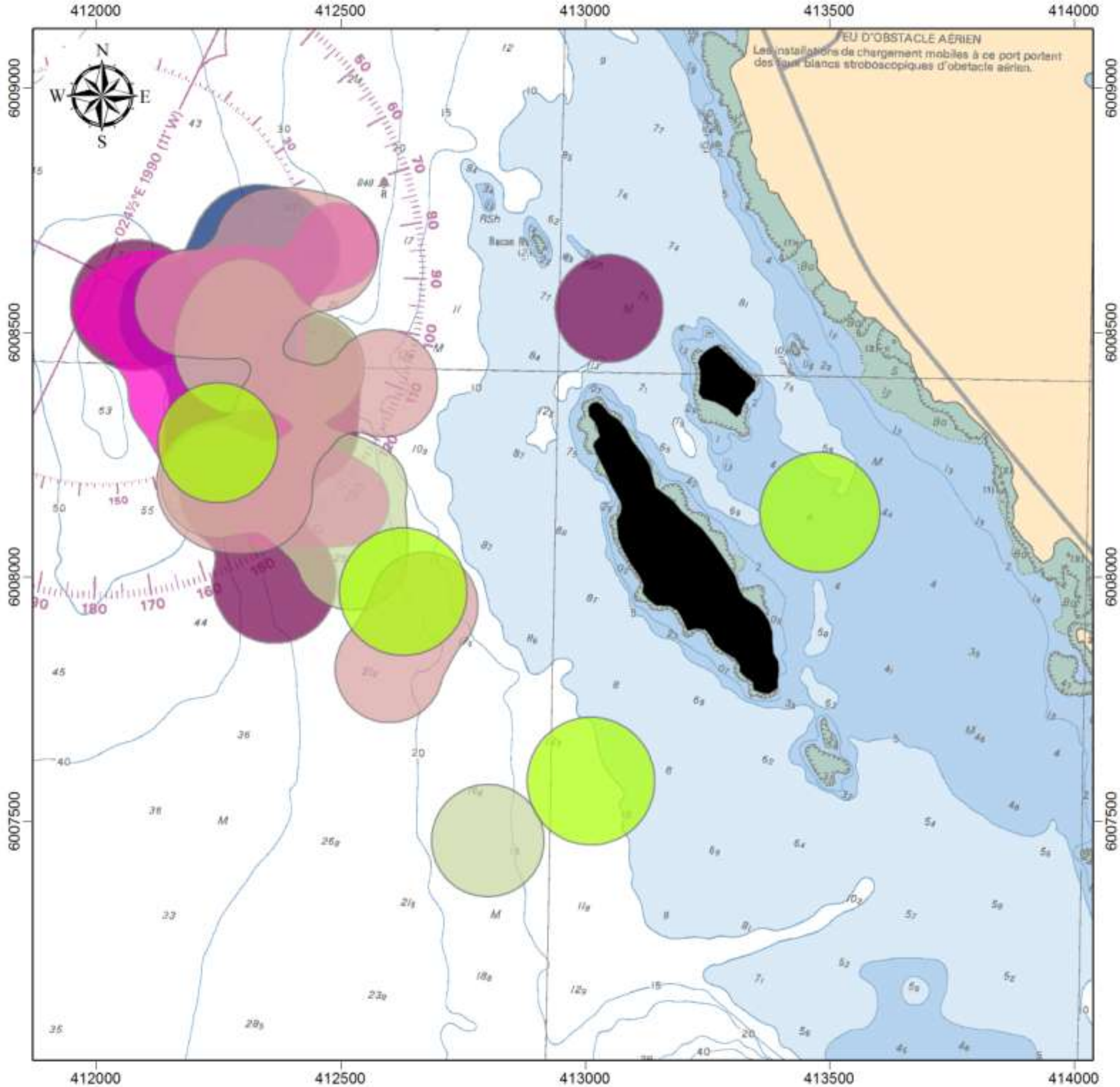
Scale: 1:11,000

Legend

- Rock mask
- California sea cucumber
- Red sea cucumber

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 35.
Range map for fish.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

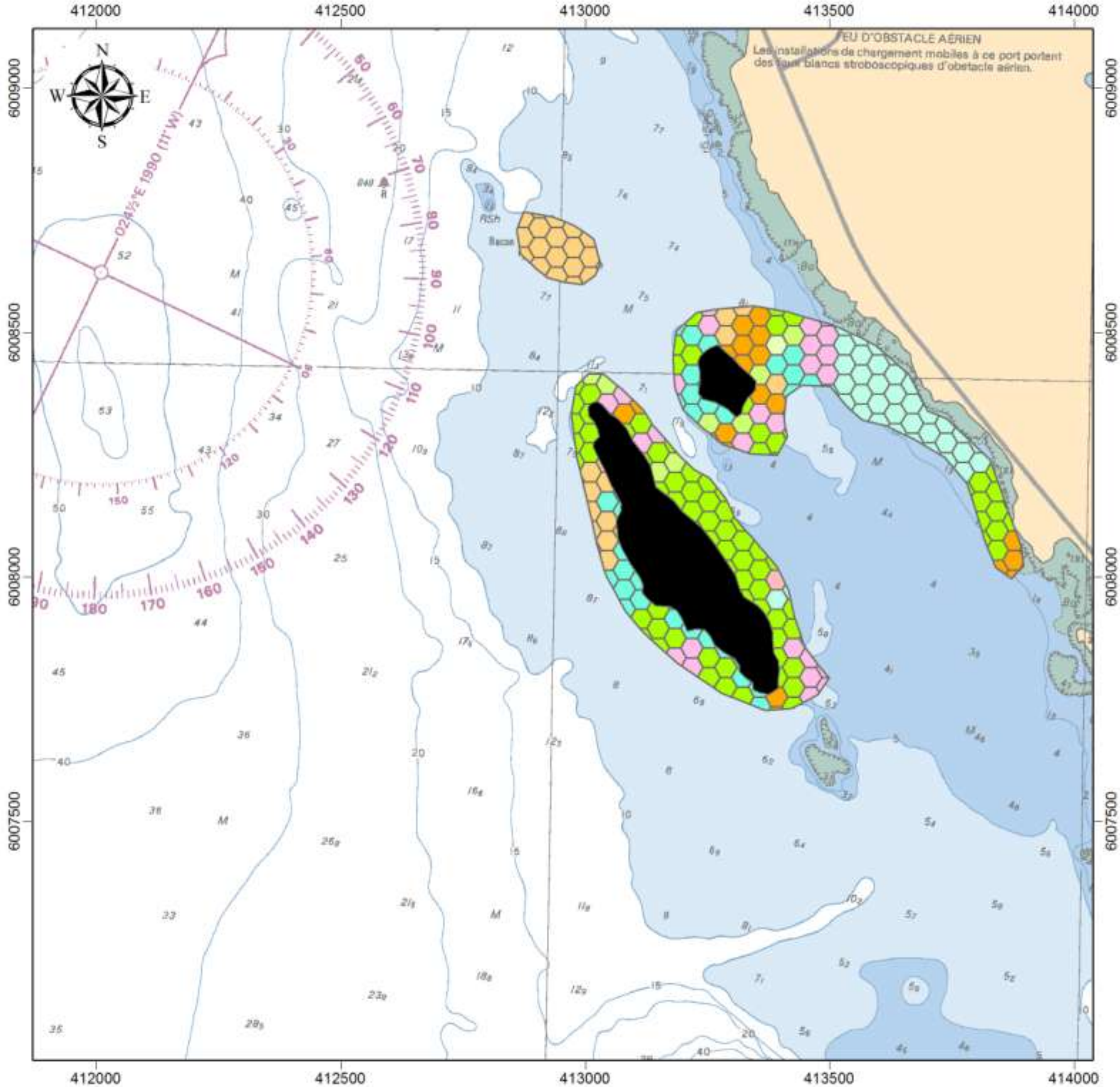
Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend
- Rock mask
- Longnose skate
- Unidentified flatfish
- Unidentified sculpin
- Northern ronquil
- Unidentified eelpout
- Unidentified fish

OCEAN ECOLOGY



Canpotex - Ridley Island
Potash Terminal
Subtidal Video Survey 2

Figure 36.
Map of dominant vegetation species.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

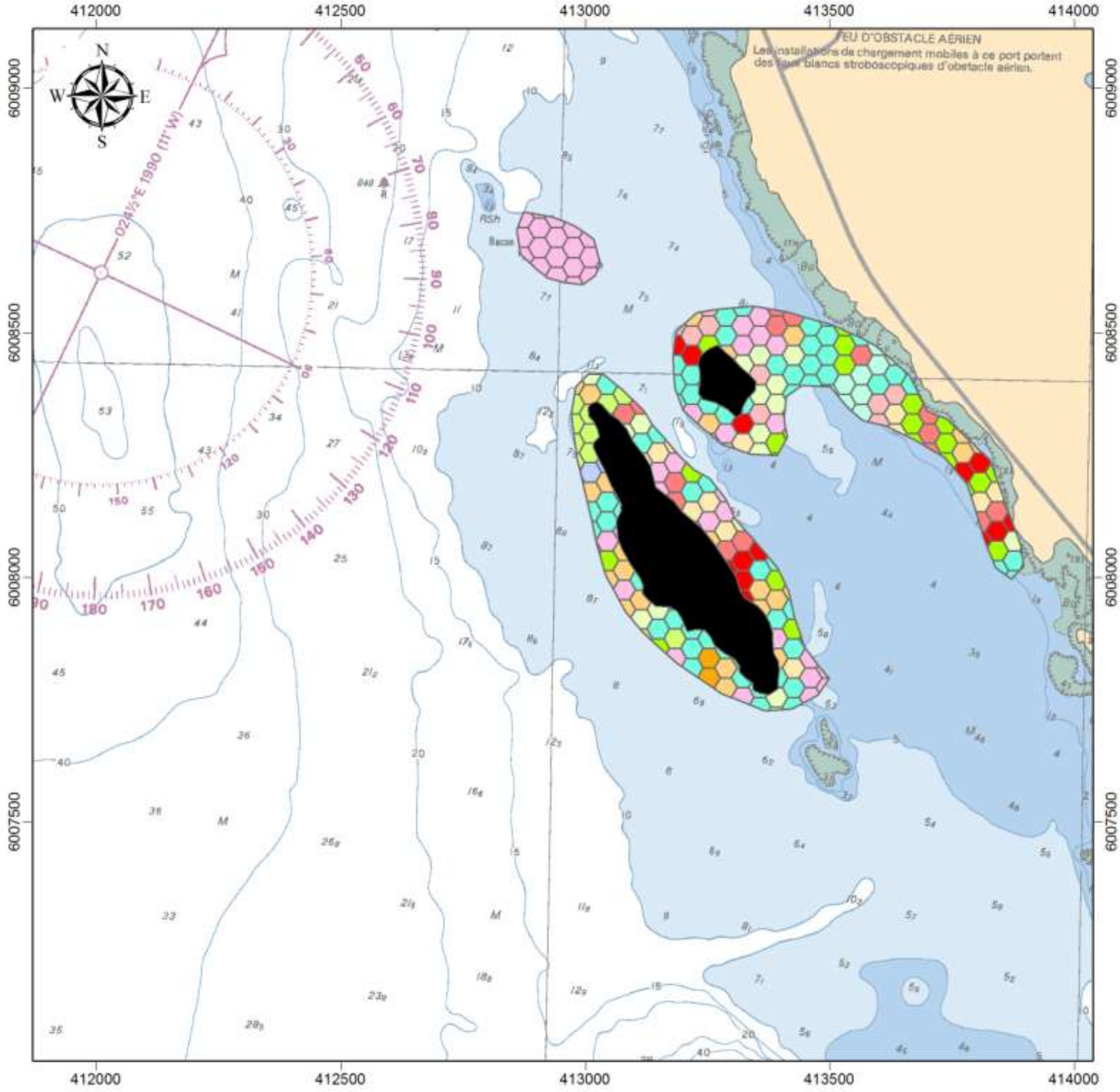
Rock mask

Dominant vegetation map

- Alaria
- Coralline reds
- Eelgrass
- Filamentous reds
- Foliose reds
- Fringed sea colander kelp
- Nereocystis
- Suction-cup kelp
- Sugar wrack kelp

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 37.
Map of minor vegetation species.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

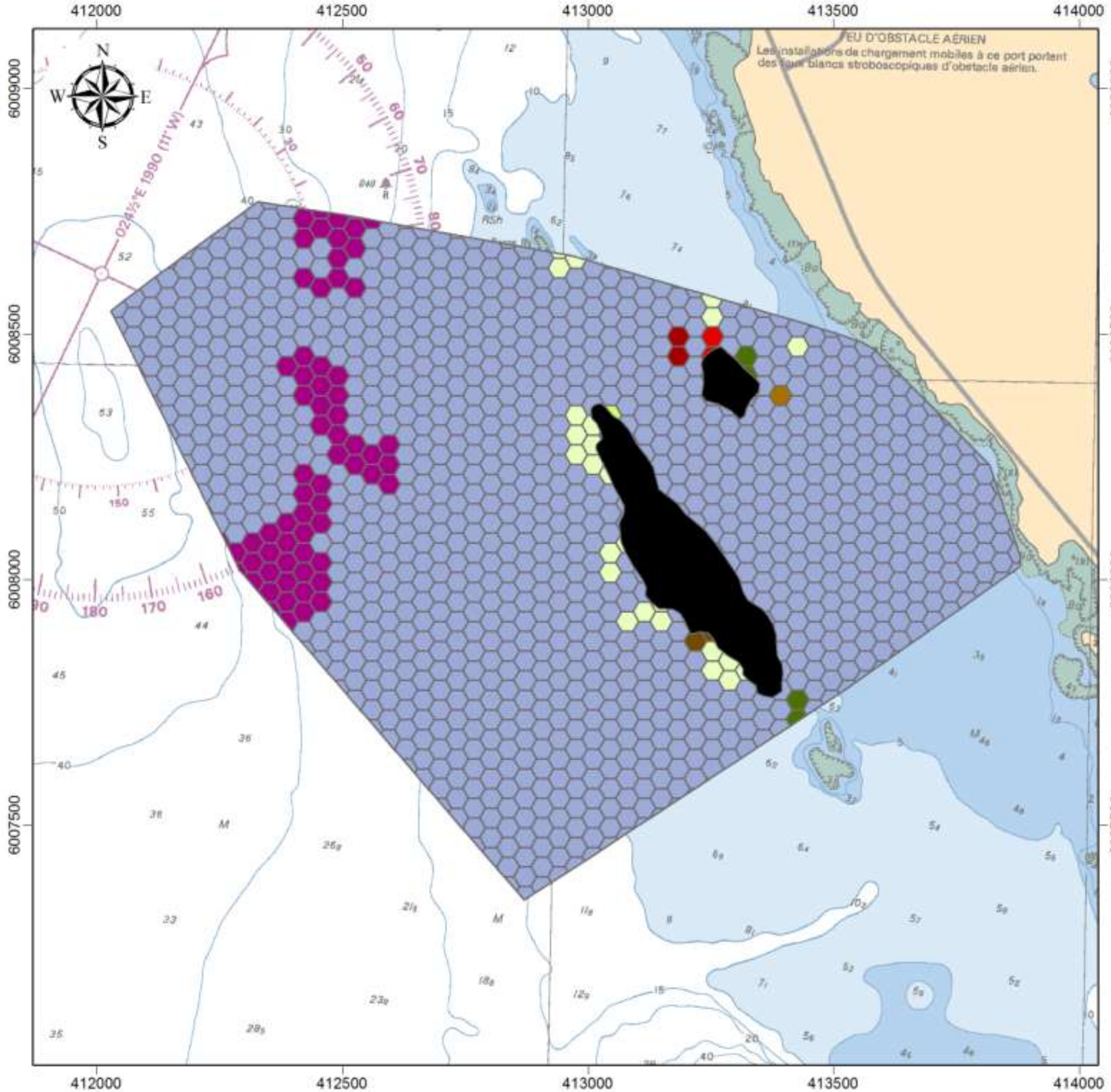
Rock mask

Minor vegetation map

- Alaria
- Broad acid weed
- Coralline reds
- Eelgrass
- Filamentous greens
- Filamentous reds
- Foliose greens
- Foliose reds
- Fringed sea colander kelp
- Nereocystis
- Stringy acid weed
- Suction-cup kelp
- Sugar wrack kelp

0 62.5 125 250 Meters

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 38.
Map of dominant fauna species.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

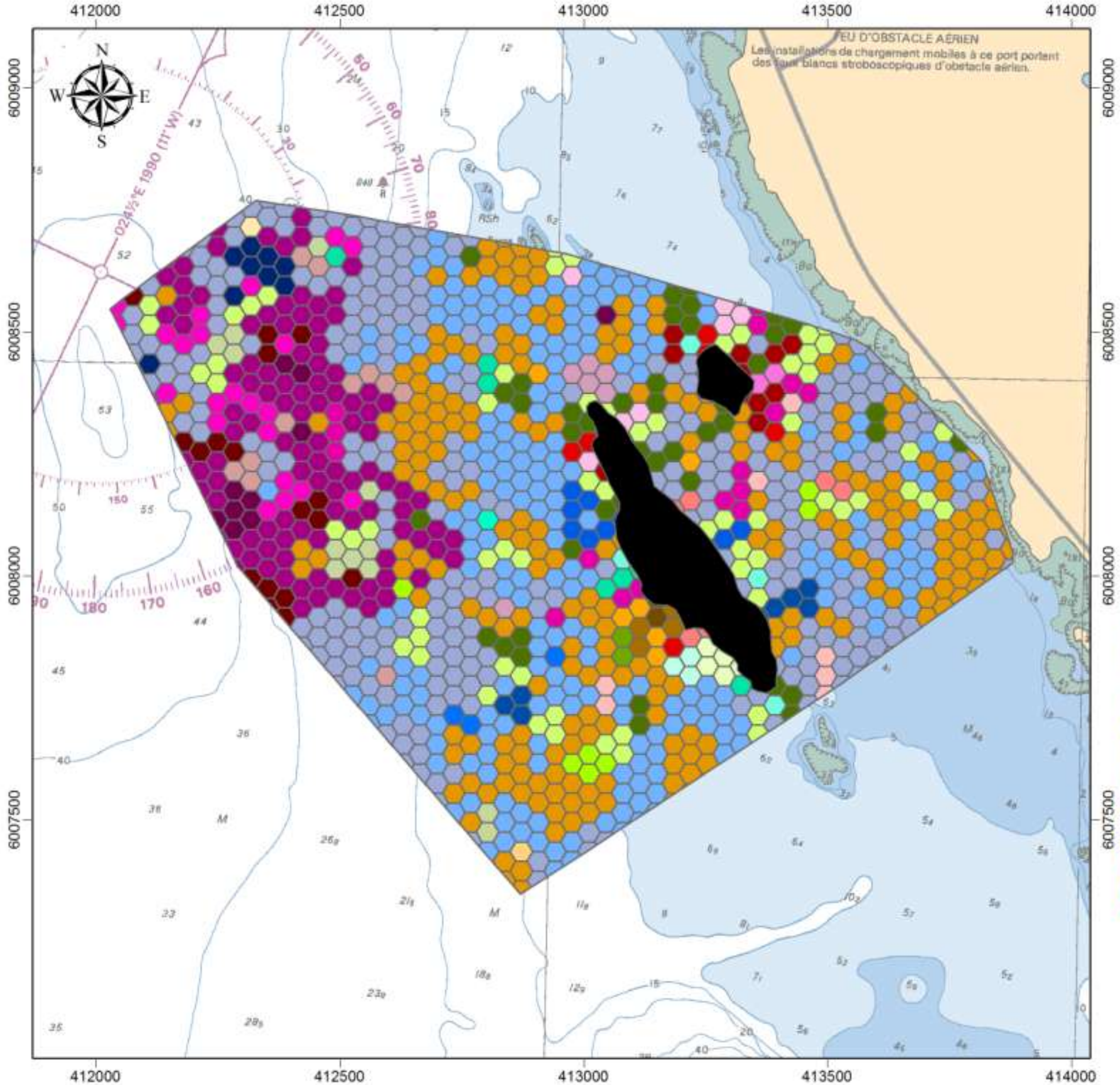
Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

OCEAN ECOLOGY



Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 39.
Map of minor fauna species.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection: WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

- Rock mask

Minor fauna map

- Bacterial mat
- Black-eyed goby
- Bryozoan complex
- Calcareous tube worm
- California sea cucumber
- Decorator crab
- Dogwinkle
- Dungeness crab
- False ochre seastar
- Geoduck clam
- Gray brittle star
- Long ray star
- Longnose skate
- Moon jellyfish
- Mounded hole
- Northern ronquil
- Ochre seastar
- Orange sea pen
- Painted star
- Parchment tube worm
- Plumose anemone
- Red sea cucumber
- Short-spined seastar
- Snake lock anemone
- Spiny mudstar
- Spiny pink shrimp
- Spot prawn
- Stalked vase sponge
- Sunflower seastar
- Unidentified eelpout
- Unidentified fish
- Unidentified flatfish
- Unidentified sculpin
- Unmounded hole
- Vermilion star

0 62.5 125 250 Meters

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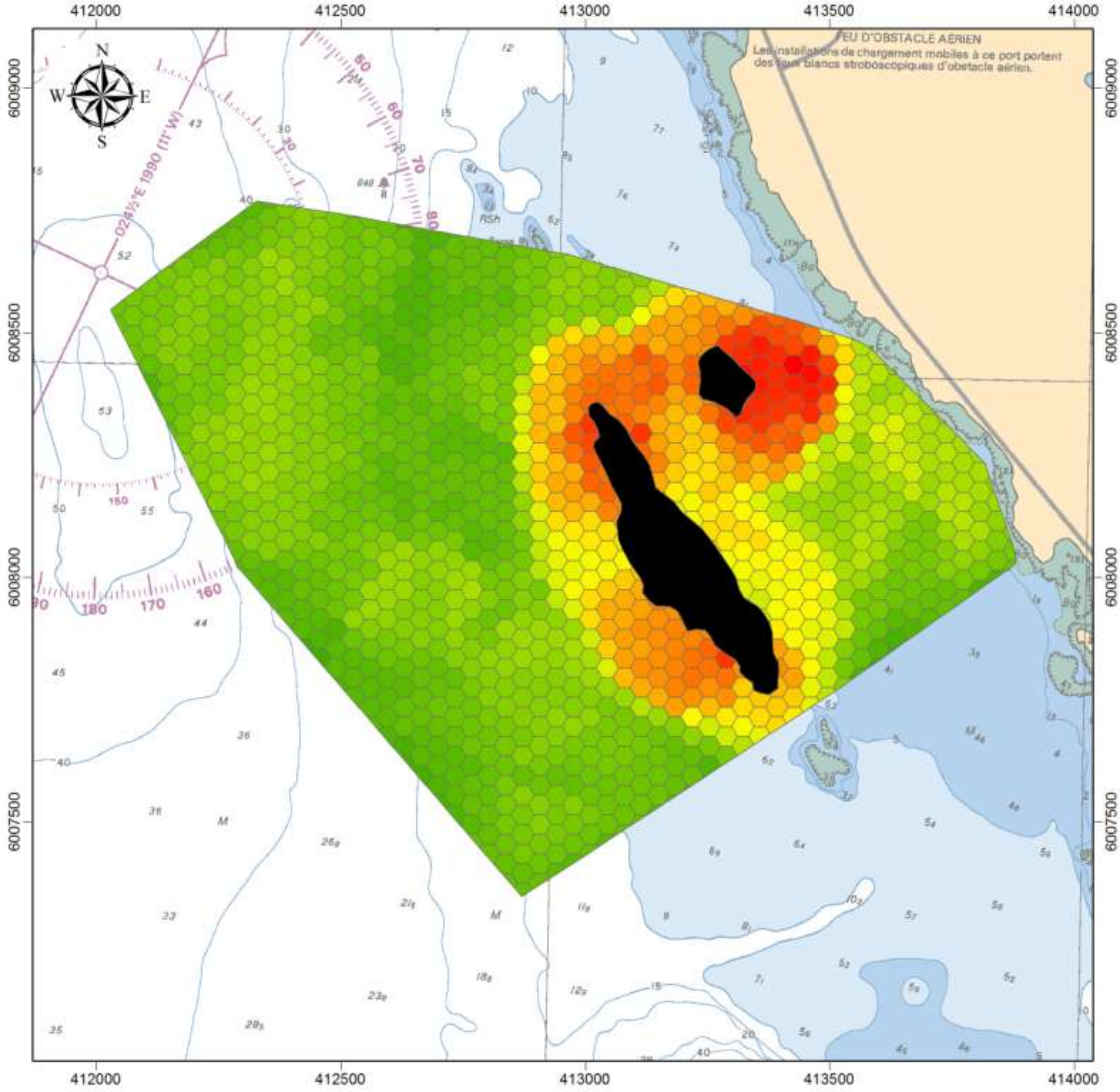

Canpotex - Ridley Island Potash Terminal Subtidal Video Survey 2

Figure 40.
Species richness map.

Positioning system:
Electronic charting software using DGPS

Survey resolution:
160 m grid.

Chart used for navigation:
CHS 395502
(Porpoise Harbour)

Chart datum: LNT

Projection:WGS 1984 UTM Zone 9N

Scale: 1:11,000

Legend

Rock mask

Species

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35

0 62.5 125 250 Meters

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4 Disclaimer

The findings presented in this report are based upon data collected during the period January 20^{th} to January 21^{st}, 2009 and May 18^{th} to May 20^{th}, 2009 using the methodology described in the Survey Methodology section of this report. Ocean Ecology has exercised reasonable skill, care, and diligence to collect and interpret the data, but makes no guarantees or warranties as to the accuracy or completeness of this data.

This report has been prepared solely for the use of the Canpotex - Ridley Island Potash Terminal Project of Jacques Whitford Stantec AXYS Ltd., pursuant to the agreement between Ocean Ecology and Jacques Whitford Stantec AXYS Ltd. Any use which other parties make of this report, or any reliance on or decisions made based on it, are the responsibility of such parties. Ocean Ecology accepts no responsibility for damages, if any, suffered by other parties as a result of decisions made or actions based on this report.

Any questions concerning the information or its interpretation should be directed to the undersigned.

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5 Appendix

Table A1. Substrate type codes.

Substrate Composition	Class	Subclass	Description
Rock (R)			Bedrock outcrop; may be partially covered with a veneer of sediment.
Veneer over bedrock (vR)			Intermittently visible bedrock covered with a thin veneer of clastic sediments.
Clastic (C)			Seabed comprised of mineral grains of gravel-, sand- or mud-sized material.
	Gravel (G)	Boulder (B)	Percentage boulder (>25.6 cm in size) on seabed.
		Cobble (CO)	Percentage cobble (6.4 to 25.6 cm in size) on seabed.
		Pebble (P)	Percentage pebble (4 mm to 6.4 cm in size) on seabed.
		Granules (GR)	Percentage granules (2-4 mm in size) on seabed.
	Sand (S)	Sand (S)	Percentage sand (0.062 to 2 mm in size) on seabed.
	Silt-mud (M)	Silt-mud (M)	Percentage silt-mud (<0.62 mm in size) on seabed.
Biogenic (B)			Surface of seabed comprised of material of biogenic origin, such as vegetation.
	Organics (O)	Shell (SH)	Percentage coarse (> 2 mm in size) shell debris on seabed.
		Organic debris (OD)	Percentage organic debris on seabed.
		Wood debris (WD)	Percentage wood debris on seabed.
Anthropogenic (A)			Features of man-made origin, such as trawl marks, anchor drag marks, or cable drag marks.

Table A2. Percentage substrate cover codes.

Class Code	Percentage Cover
1	T-5%
2	5-30%
3	30-50%
4	50-80%
5	>80%

Table A3. Vegetation codes.

Algal Class	**Subclass**	**Code**	**Description**
Green Algae (GRA)	Foliose greens	FOG	Primarily *Ulva*, but also including *Enteromorpha* and *Monostroma.*
	Filamentous greens	FIG	The various filamentous green/red assemblages (*Spongomorpha/Cladophora* types).
Brown Algae (BA)	Fucus	FUC	*Fucus* and *Pelvetiopsis* species groups.
	Sargassum	SAR	*Sargassum* is the dominant and primary algal species.
	Nemalion	NEM	Filamentous *Nemalion* sp*.* is the dominant species*.*
	Soft brown kelps	BKS	Large laminarian bladed kelps, including *L. saccharina* and *groenlandica*, *Costaria costata, Cymathere triplicata.*
	Seersucker kelp	SEE	*Costaria costata.*
	Split kelp	SPL	*Laminaria setchellii.*
	Sugar wrack kelp	SWK	*Laminaria saccharina.*
	Suction-cup kelp	SUC	*Laminaria yezoensis*.
	Dark brown kelps	BKD	The LUCO chocolate brown group,. *L. setchelli, Pterygophora, Lessoniopis. Alaria* and *Egregia* may also be present. Generally more exposed than soft browns.
	Alaria	ALA	*Alaria* sp*.*
	Agarum	AGR	*Agarum* is the dominant species, but other laminarians may also occur. Generally found deeper than Laminarian subgroup.
	Fringed sea colander kelp	FSC	*Agarum fimbriatum*.
	Stringy acid weed	STW	*Desmarestia viridis.*
	Broad acid weed	BRW	*Desmarestia lingulata.*
	Macrocystis	MAC	Beds of canopy forming giant kelp.
	Nereocystis	NER	Beds of canopy forming bull kelp.

Table A3. Continued.

Algal Class	**Subclass**	**Code**	**Description**
Red Algae (RED)	Foliose reds	FOR	A diverse species mix of foliose red algae (*Gigartina*, *Iridea, Rhodymenia, Constantinia*) which may be found from the lower intertidal to depths of 10 m primarily on rocky substrate.
	Filamentous reds	FIR1	A diverse species mix of filamentous red algae (including *Gastroclonium, Odonthalia, Prionitis*) which may be found from the lower intertidal to depths of 10 m, often co-occurring with the foliose red group described above.
	Filamentous reds	FIR2	A mix of red algae (primarily *Neoagardhiella*and *Gracilaria*) which grow on "submerged" cobble and pebble in fine sand and silt bottoms.
	Coralline reds	COR	Rocky areas with growths of encrusting and foliose forms of coralline algae.
	Halosaccion	HAL	*Halosaccion glandiforme.*
Seagrasses (SGR)	Eelgrass	ZOS	Eelgrass beds.
	Surfgrass	PHY	Areas of surfgrasses (*Phyllospadix*), which may co-occur with subgroup BKS or BKD above.
No Vegetation		NOV	No vegetation observed.
Cannot Classify		X	Vegetation present by cannot be identified. Imagery is not clear, classification not possible.

Table A4. Vegetation coverage codes.

Code	Class	Abundance
1	Sparse	Less than 5% cover.
2	Low	5 to 25% cover.
3	Moderate	26 to 75% cover.
4	Dense	>75% cover.

Table A5. Fauna codes.

Species or Species Complex	Code	Description
Bacterial mat	BCM	Unidentified bacterial mat; sulfuretum.
Sponges	USP	Unidentified sponge.
	CLD	Cloud sponge (*Aphrocallistes vastus*).
	SBS	Sharp lipped boot sponge (*Rhabdocalyptus dawsoni*).
	RSB	Round lipped boot sponge (*Staurocalyptus dowlingi*).
	SVS	Stalked vase sponge (*Leucilla nuttingi*).
	BRS	Breast sponge (*Eumastia sitiens*).
Jellyfish	MJF	Moon jellyfish (*Aurelia labiata*).
	CYC	Lion's mane jellyfish (*Cyanea capillata*).
Hydroids	HYD	Unidentified hydroids.
	HYM	Hydromedusa sp.
Anemones	PAF	Tube-dwelling anemone (*Pachycerianthes fimbriatus)*.
	MET	Plumose anemone (*Metridium* sp.).
	URT	Sea anemone (*Urticina* sp.).
	XAN	Giant green anemone (*Anthopleura xanthogrammica*).
	CRI	Snake lock anemone (*Cribrinopsis* sp.).
	ANT	Sea anemone (*Anthopleura* sp.).
	STR	Strawberry anemone (*Corynactis californica*).
Corals/Hydrocorals	SPO	Orange sea pen (*Ptilosarcus gurneyi*).
	SPW	White sea pen (*Virgularia* sp.).
	CUP	Orange cup coral (*Balanophyllia elegans*).
	SWP	Sea whip (*Balticina septentrionalis*).
	STY	Pink hydrocoral (*Stylaster* sp.).
Worms	TUB	Parchment tube dwelling polychaete worms.
	TUC	Calcareous tube dwelling polychaete worms.
	LUG	Pacific lugworm (*Abarenicola pacifica*).

Table A5. Continued.

Species or Species Complex	Code	Description
Crabs	CRB	Unidentified crab.
	CAN	*Cancer* sp.
	DUN	Dungeness crab (*Cancer magister*).
	TAN	Tanner crab (*Chionoecetes* sp.).
	KCR	Kelp crab (*Pugettia* sp.).
	BXC	Box crab (*Lopholithodes foraminatus*).
	ORE	Decorator crab (*Oregonia gracilis*).
	SQT	Squat lobster (*Munida quadraspina*).
Shrimps (Pandalid)	PAN	Unidentified pandalid.
	PRN	Spot prawn (*Pandalus platyceros*).
	PNB	Spiny pink shrimp (*Pandalus borealis*).
	PNH	Humpback shrimp (*Pandulus hypsinotus*).
Ghost and mud shrimps	GHS	Ghost shrimp (*Callianassa californiensis*).
	MDS	Mud shrimp (*Upogebia pugettensis*).
Gastropods	WHK	Unidentified whelk.
	NUC	Dogwinkle (*Nucella* sp.).
	WLN	White-lined nudibranch (*Dirona albolineata*).
	TOT	Orange-peel nudibranch (*Tochuina tetraquetra*).
Bivalves	MUS	Mussel bed (*Mytilus trossulus*).
	GCL	Geoduck clam (*Panopea abrupta*).
	HCL	Horseclam (*Tresus* sp.).
	PCL	Piddock clam.
	BCL	Butter clam (*Saxidomas gigantea*).
	COC	Nuttall's cockle (*Clinocardium nuttallii*).
	SFC	Softshell clam (*Mya* sp.).
	OYS	Oyster.
	OCL	Other clam species.
	SCA	Scallop (*Chlamys* sp.)
	TER	Teredo worm (*Bankia setacea*).
Octopus	OCT	Pacific octopus (*Octopus*).
Bryozoan Complex	BRY	Bryozoans, ascidians, sponges - generally on rock substrate.
Brachiopods	BRA	Unidentified brachiopod.
	LAM	California lamp shell (*Laqueus californicus*).

Table A5. Continued.

Species or Species Complex	Code	Description
Seastars	BRE	Short-spined seastar (*Pisaster brevispinus*).
	EVA	False ochre seastar (*Evasterias troschelli*).
	PYC	Sunflower seastar (*Pycnopodia helianthoides*).
	POR	Ochre seastar (*Pisaster ochraceus*).
	DER	Leather star (*Dermasterias imbricata*).
	GEP	Gunpowder star (*Gephyreaster swifti*).
	WRS	Wrinkled star (*Pteraster militaris*).
	PTT	Slime star (*Pteraster tesselatus*).
	VER	Vermilion star (*Mediaster aequalis*).
	HEN	Seastar (*Henricia* sp.).
	SOL	Seastar (*Solaster* sp.).
	COO	Cookie star (*Ceremaster patagonius*).
	PLS	Pale star (*Leptychaster pacificus*).
	SMS	Spiny mudstar (*Luidia foliolata*).
	ORT	Painted star (*Orthasterias koehleri*).
	STF	Long ray star (*Stylasteria forreri*).
	SIX	Six-armed star (*Leptasterias* sp.).
	ROS	Rose star (*Crossaster papposus*).
	STR	Unidentified seastar.
Brittle Stars	BRT	Unidentified brittle star.
	GYB	Gray brittle star (*Ophiura lütkeni*).
Basket Stars	BSK	Basket star (*Gorgonocephalus* sp.).
Feather Stars	FST	Feather star (*Florometra serratissima*).
Sand Dollars	SDD	Sand dollar (*Dendraster excentricus*).
Sea Urchins	RSU	Red sea urchin (*Strongylocentrotus franciscanus*).
	GSU	Green sea urchin (*Strongylocentrotus droebachiensis*).
	WSU	White sea urchin (*Strongylocentrotus pallidus*).
	PSU	Purple sea urchin (*Strongylocentrotus purpuratus*).
Sea Cucumbers	RCU	Rea sea cucumber (*Cucumaria miniata*).
	WCU	White sea cucumber (*Psolus squamatus*).
	PAR	California sea cucumber (*Parastichopus californicus*).
	ASC	Aggregating sea cucumber (*Pseudocnus* sp.).
Tunicates	TUN	Unidentified tunicate.
	CIO	Tunicate (*Ciona* sp.).
	PEA	Pacific sea peach (*Halocynthia aurantium*)
In fauna "holes"	HLM	Mounded worm, clam or crustacean hole, but species or species group cannot be distinguished.
	HLF	Unmounded (flat) worm or clam hole, but species or species group cannot be distinguished.

Table A5. Continued.

Species or Species Complex	Code	Description
Fish	FSH	Unidentified fish.
	SAL	Unidentified salmonid.
	ELP	Unidentified eelpout (Zoarcidae).
	POA	Unidentified poacher.
	GBE	Black-eyed goby (*Coryphoterus nicholsi*).
	PLP	Pile perch (*Rhacochilus vacca*).
	PST	Striped perch (*Embiotica lateralis*).
	FTF	Unidentified flatfish.
	RFS	Unidentified rockfish.
	BRF	Black rockfish (*Sebastes melanops*).
	NRK	China rockfish (*Sebastes nebulosus*).
	CRK	Copper rockfish (*Sebastes caurinus*).
	QRF	Quillback rockfish (*Sebastes maliger*).
	TRF	Tiger rockfish (*Sebastes nigrocinctus*).
	YRF	Yelloweye rockfish (*Sebastes ruberrimus*).
	GLG	Unidentified greenling (Hexagrammid).
	KGR	Kelp greenling (*Hexagrammos decagrammus*).
	LNG	Lingcod (*Ophiodon elongatus*).
	SCU	Unidentified sculpin (Cottidae).
	NRN	Northern ronquil (*Ronquilus jordani*).
	RAT	Ratfish (*Hydrolagus colliei*).
	LSK	Longnose skate (*Raja rhina*)
Unknown	UNK	Macro fauna visible but cannot be identified.
No Fauna	**NOF**	No fauna observed.

Table A6. Faunal distribution classes.

Code	Descriptor	Distribution
1	Few	Rare (single) or a few sporadic individuals.
2	Patchy	A single patch, several individuals or a few patches.
3	Uniform	Continuous uniform occurrence.
4	Continuous	Continuous occurrence with a few gaps.
5	Dense	Continuous dense occurrence.
6		Code specific for school of fish.